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We adopt a new Keynesian approach and develop a Dynamic Stochastic General Equilibrium (DSGE) model in order to simulate the empirical evidence. Both the larger persistence of shocks in military spending and the different financing mechanisms, which account for the propensity of policy-makers to use budget deficits to finance wars, mimic the differences in the empirical responses of private consumption. Simulated impulse response functions of alternative specification models prove the robustness of our analysis. In particular, we assess the impact of civilian and military shocks in the presence of different: i) shares of heterogeneous households; ii) price rigidities; iii) monetary reactions in response to diverse government shocks.

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Introduction

Recently, US public opinion has showed renewed interest in the economic impact of fiscal policy. At the end of 2013, an intense debate and media coverage concerned the US federal government shutdown. The tensions that ultimately produced this shutdown arose due to the different perspectives of policy-makers concerning the deficit reduction through a simultaneous increase in tax rates and decrease in government spending.[1] The main motivation of this debate is that the economic literature did not provide conclusive results regarding how public expenditure and its financing mechanism can affect the economic performance of private sector. In general, contrasting results mainly depend on the theoretical perspective and the empirical methodology used (Cogan et al., 2010).

The neoclassical approach suggests a strategic explanation to account for the economic effects of large cyclical rises in government spending. Based on major unexpected political events, it assumes that the periods of increased military spending correspond to the dates of war or threats of war. Ramey & Shapiro (1999), later extended by Ramey (2011), proposed a so-called "narrative" approach, which selected the start of the three wars in which the US actively intervened (i.e., Korean, Vietnam and the Soviet invasion

[1] In this regard, Feldstein (2008) argued that any Department of Defense (DoD) budget cuts may be misguided. He also suggested that in the recent downturn cycle, the US government should have recognized the need to increase government spending to offset the decline in consumer demand in the economy, and stated that a rise in military spending would be the best way to provide this stimulus.

of Afghanistan) and the 2001 terrorist attack, to identify empirically large exogenous increases in US defense spending. The significant criticism of this approach (modeled by the "Expectations Augmented Vector Autoregressive", EVAR, specifications) is that other substantial fiscal shocks may have occurred at the same time. In turn, these other shocks may interfere with the identification of military shocks, implying distorted results.[2]

The economic literature has proposed an alternative approach to test the effects of fiscal policy on economy. In particular, a large set of studies has focused on Structural Vector Autoregressive (SVAR) models with differences in the identification issues of fiscal shocks.[3] Although Bouakez, Chihi & Normandin (2014) have recently criticized this approach, Perotti (2014) has clearly shown that SVAR models properly identified achieve the same results of the EVAR by Ramey (2011).

In this paper, we review the economic consequences of changes in the US fiscal policy following a baseline SVAR model extended for the fiscal components of military and civilian spending. The main question of interest is whether unexpected military and non-military expenditures produce

[2] As an example of this debate, Perotti (2005) at page 5 argues that 'Ramey and Shapiro date the start of the Korean war shock in 1950:Q3, based on the large observed increase in military spending; but in four quarters between 1948:Q2 and 1950:Q3, government spending increased by between two and three standard deviations. It is not obvious how to disentangle the effects of the Korean dummy variable from the delayed effects of these large fiscal shocks'.

[3] A very large body of empirical literature includes structural restrictions of impulse response functions (Enders, Muller & Scholl, 2011), relations among variables and error terms in the structural form (Corsetti, Meier & Muller, 2012), or external institutional information, which tends to exploit the quarterly nature of data and fiscal policy decision lags (Perotti, 2005).

"contractionary" or "expansionary" effects on private consumption, respectively. We contribute to the existing literature by showing that differences on private consumption effects are based on how the shocks of government spending components are driven by their persistence and types of financing mechanisms.

We base our hypotheses on the findings of Gali, Lopez-Salido & Valles (2007) who show that a positive government spending shock leads to a significant increase in private consumption when defense expenditure is excluded. Accordingly, they infer the hypothesis that military spending has a negligible or negative impact on consumption. However, previous literature found conflicting empirical results about the effects of different public spending components on consumption and other macroeconomic variables. Using a partial equilibrium model Pieroni (2009) has shown that private consumption responds negatively to military expenditure increases. In terms of private investment, the findings by Smith (1980) show the so-called "crowding-out" effect. On the contrary, Aschauer (1989) provided evidence that positive government spending shocks induce an increase in private investment. More recently, F-deCordoba & Torres (2016), using a DSGE model with a security factor in the utility function, have found that the increase in the external threat induces a rise in military spending, investment and output while it reduces consumption. Finally, Malizard (2015) provided evidence of a positive effect on private investment due to military equipment spending (considered as public investment) for the case of France.

As in Blanchard & Perotti (2002), who estimated output fiscal effects, we report a comparison of the Vector Autoregressive (VAR) effects of military and civilian spending shocks on consumption for the US: although we estimate a negative effect of military expenditure on consumption, our results show that civilian government purchases have a largely positive effect on private consumption. In order to check the robustness of our empirical analysis, we compare the different impacts of civilian and military spending for two subsamples that correspond to the periods before and after the "Great Moderation".[4] Our results indicate that the transmission channels of both civilian and military shocks have changed over time. Regarding civilian spending, we find that the responses of macroeconomic aggregates are less significant in the post-1980 sample. On the contrary, the effects of military shocks are mostly significant in the second subsample.

In this paper, following the most recent literature (see, among others, Jacob, 2015), we develop a new Keynesian model to mimic the empirical results. This framework offers the advantage of taking into account forward-looking expectations of households and firms, and encompasses many ingredients of modern dynamic optimizing sticky-price models, although it is modified by allowing for the presence of consumers subject to credit constraints. In particular, we consider an economy populated by a continuum of infinitely lived

[4]With the term "Great Moderation" we refer to the period in which the US economy experienced a reduction in the volatility of business cycle fluctuations. In particular, starting in the 1980s major US economic variables such as real gross domestic product and inflation began to decline in volatility.

households that are divided into Ricardians and non-Ricardians. Ricardians can trade securities and accumulate physical capital, whereas non-Ricardians do not have access to capital markets and simply consume their current labor income.[5] The advantage of such approach is straightforward. Despite the negative wealth effect associated with an increase in the tax burden, the response of aggregate consumption to a spending shock can be positive under the presence of non-Ricardian consumers (Gali, Lopez-Salido & Valles, 2007).

In our theoretical model, we extend the original framework of Bilbiie, Meier & Muller (2008) by disentangling civilian and military spending shocks. We motivate our framework according to the two main findings of our empirical estimates. First, we observed a stronger persistence of military spending shock than civilian spending shock. In particular, the high persistence of the military spending shock increases the negative wealth effect on Ricardian households and further lowers their consumption spending. As a consequence, we observe the fall in aggregate consumption in response to this shock. Second, our empirical estimates show the effects of a different financing mechanism of civilian and military expenditures. The former is mainly financed by the increase in taxation rate, while the latter is mainly funded by government budget deficit. In this regard, the heterogeneity of consumers also implies different transmission channels through which fiscal policy af-

[5]See Campbell & Mankiw (1989) for the original description of the economic behavior of non-Ricardian consumers, and Baker (2015) for the importance of debt held by households in the presence of income fluctuations.

fects the economy. In our analysis, this issue is particularly important in order to examine the different effects of military and civilian spending. In contrast to Favero & Giavazzi (2007), who explicitly include the long run government budget constraint, the new Keynesian model presented below comprises, along with a taxation rule, a deficit financing rule.

Our simulated results of the baseline new Keynesian model show that private consumption responds positively to civilian spending whereas military expenditure negatively affects private consumption. Some robustness tests are presented in order to compare the dynamic responses of private consumption to a different persistence and financing mechanisms of civilian and military spending shocks. We also analyze the impact of these two components of government spending on private consumption in the cases of different shares of Ricardian households and degrees of price rigidities. Finally, we assess the effects of different fiscal shocks when monetary policy changes.

The rest of this paper is organized as follows. Firstly, we discuss the basic literature and some stylized facts of how the US finances government spending, in particular within the identified war dates. Secondly, we present our empirical specifications showing the data and discussing the empirical results. Thirdly, we present our theoretical framework and the model calibration. Fourthly, we examine the simulated impulse responses of consumption to the different government spending shocks and the robustness analysis. Finally, we offer a concluding discussion.

Private consumption and the financing mechanism of military expenditure

Barro (1979, 1981) conducted several studies highlighting the economic effects of government spending and the alternative methods and impacts of financing this expenditure. In particular, Barro (1981) stressed the fact that government expenditures can provide direct welfare to economic agents and that variations in the level of government expenditure may have an impact on the consumption decisions of households. Based on this work, one strand of the literature shows that different financing sources of public sector components lead to heterogeneous effects on private consumption when consumers are constrained in their asset purchases.

In this section, we focus on the different mechanisms used to finance military spending in the US. We focus on the shocks near wartime, including threats of war. Our analysis follows the US war episodes described by Ramey (2011) except for the Korean War, which is outside our sample. In particular, we focus on the patterns of government budget deficit and tax revenues. In this regard, in the left column of Figure 1, dashed black lines indicate the "actual" patterns of US government deficit in each war episode. As a comparison, solid black lines denote the "counterfactual" levels of government budget deficit, assuming no change relative to the first quarter of each war episode. Similarly, the right column of Figure 1 shows the same comparison in the case tax revenues. We observe that government deficit substantially increases in all these episodes. On the contrary, tax revenues fall over the same periods. The only exception is the Carter-Reagan military buildup. However, we note that this increase is much lower (about 1%) than the rise in government deficit (about 6%) implying that almost the whole burden of military outlay has been financed through borrowing from the public.

We emphasize our paper's contribution arguing that the effect of military spending on private consumption also depends on the financing mechanism. In particular, unplanned episodes such as wars are generally financed by budget deficits. Thus, from a Keynesian perspective, since greater military outlay is not offset by the contraction induced by higher taxes, wars typically cause a short-term economic boom boosting aggregate demand and consumption. As argued by Nincic & Cusack (1979) and Krell (1981), this is one of the main economic explanations of increases in military spending. However, Barker, Dunne & Smith (1991) have shown that such increases have contractionary effects on the UK economy. In particular, these authors assumed that the defense reductions are matched by balanced increases in other public expenditures. As a consequence, they found that consumption expenditures and GDP increase in response to cuts in military spending. Given these conflicting findings, our main objective is to provide a more formal assessment of the effects of different public spending components on private consumption accounting for the several transmission channels through which these shocks affect the US economy.

Figure 1 in here

Empirical evidence

In this section, we empirically analyze several transmission mechanisms through which public spending components affect private consumption. In particular, we estimate the impulse response functions based on the shocks to civilian and military expenditures.

Specification and identification

As a baseline specification of our model, we adopt a SVAR. Its reduced form is defined by the following dynamic equation:

$$Y_t = c + A\left(L\right)Y_{t-1} + U_t \quad (1)$$

where Y_t indicates the vector of variables specified below, $A(L)$ is an autoregressive lag polynomial, c a constant term, and U_t the vector of reduced-form innovations. Our analysis is focused on the US economy and our sample period is 1960:Q1−2013:Q4, which is chosen for reasons of data availability. In particular, we use the OECD Economic Outlook No. 90 Database as primary source for most of our variables.[6] The quarterly series for military and

[6] Although there are more recent versions of the OECD Economic Outlook Database, some of these updated series are not consistent with the data in the earlier years of our sample.

civilian spending are taken from the Bureau of Economic Analysis. As a limitation of our analysis, the absence of longtime series at quarterly frequency for government spending components in other countries different from the US does not allow us an international comparison.

Our empirical strategy based on quarterly data is in line with the new Keynesian perspective, which sustains that a discretionary fiscal policy plausibly does not respond within a quarter to a change in the economy.[7] From an empirical point of view, a substantial issue is associated with the perspective that private agents receive signals about future changes in government spending before these changes take place. This, in turn, should affect the validity of the SVAR representation. In particular, the anticipation effect of the expenditure in the military sector argued by Ramey (2011) may lead to differences in the shock effects of this component on the economy. Therefore, following previous economic literature on this topic, we include dummy variables in the "military" VAR system controlling for anticipation effects.[8] More specifically, these dummies correspond to the dates accounting for the major military events, as described in Ramey & Shapiro (1999). These dates are: 1965:Q1, 1980:Q1, 2001:Q3.[9]

We estimate the impulse responses of military and civilian spending shocks separately with a five-variable VAR because they are not significantly linked,

[7]We follow the approach used by Auerbach (2000).

[8]See, for example, Leeper, Walker & Yang (2013).

[9]With respect to Ramey (2011), the Korean date (1950:Q1) is excluded because it is outside of our sample.

identifying different transmission effects on economy. Following the strategy outlined in Equation (1), first we specify the model analyzing the effects of the civilian component:

$$Y_t = [C_t, W_t, DINC_t, BD_t, NM_t] \tag{2}$$

where C_t denotes the log of real private consumption, W_t the log of real wage, $DINC_t$ the log of real disposable income, BD_t the government budget deficit and NM_t the civilian spending. More specifically, civilian spending is obtained as the difference between government consumption expenditure and national defense data.[10] Both civilian spending and budget deficit enter the VAR as a ratio of current GDP. Our choice is motivated both by the easier interpretation in terms of measurement of consumption responses that are expressed as unit changes and in order to be consistent with our DSGE model (see, for example, Gali, Lopez-Salido & Valles, 2007; Bilbiie, Meier & Muller, 2008). All the remaining real variables are expressed in per capita terms.[11]

As an identification strategy for fiscal policy shocks, we adopt a Cholesky factorization in order to recover the vector of structural shocks ϵ_t (and its variance Ω) from the reduced-form error U_t in Equation (1). It is worth-

[10]Since we are interested in the short-run effects of government spending shocks on private consumption, we omit public investment from the data. As a robustness check, we considered both public consumption and public investment and we obtained results that are very close to those presented below.

[11]The Online appendix provides a detailed description of data sources and construction.

while noticing that the structural identification of Blanchard & Perotti (2002) of government spending shocks is identical to a Choleski decomposition, in which government spending is ordered before the other variables.[12] In particular, we assume the following set of conditions. We consider civilian spending as the most exogenous variable. The interaction between civilian expenditure and taxation rate influences the budget deficit: if the civilian spending increase is financed by tax rises, the budget deficit may be negative. Conversely, if a civilian expenditure rise is not followed by a corresponding increase in taxation rate, the budget deficit is positive. We implicitly allow for heterogeneous consumers (namely, Ricardians and non-Ricardians). Because household demand for goods depends on the expected value of taxes (i.e., disposable income), each household subtracts its share of this present value (real wage) from the expected present value of income in order to determine a net wealth position. Lastly, we consider private consumption as the most endogenous variable, which is therefore affected by all contemporaneous values of all the variables in the VAR.

Since our main focus is on the comparison of the private consumption effects of civilian and military shocks, we repeat the same experiment substituting civilian expenditure (NMt) with military spending (Mt) in the VAR model. In this case, the vector of variables Y_t in Equation (1) may be

[12] As in Blanchard & Perotti (2002), the condition for identification is that the component of government spending does not respond to government or private macroeconomic variables, contemporaneously.

expressed as:

$$Y_t = [C_t, W_t, DINC_t, BD_t, M_t] \tag{3}$$

Similar to the civilian spending case, military spending enters the VAR as a ratio of current GDP. Again, we adopt a Cholesky factorization in which private consumption, real wages, disposable income and budget deficits are allowed to depend on the fiscal variable (in this case, military expenditure) and are ordered, respectively.

Finally, we focus on one issue that has been highly disputed in the recent literature on the effects of fiscal components on the economy. In particular, many authors (see, for example, Leeper, Plante & Traum, 2010) have argued that the specific characteristic of the government expenditure in VAR models is its persistence driven by the presence of trends. In this regard, military spending has a clear downward trend, while civilian spending is more stationary.[13] In general, the presence of trends in fiscal series (as shares of GDP) is not limited to non-defense spending, but is pervasive. For instance, in the dataset used by Leeper, Plante & Traum (2010) to estimate a DSGE model using Bayesian techniques, tax revenues, transfers, and government spending (all as shares of GDP) have different trends. Therefore, we deal with those trends, including the linear trend in the model specification.

[13] See Figure E1 in the Online appendix.

Results

We estimate two VAR models according to Equations (2) and (3) in order to obtain the empirical Impulse Response Functions (IRFs). According to the Schwarz information criterion, the number of lags is set to two. Diagnostic tests indicate the absence of serial correlation in the residuals by a Lagrange Multiplier test. We do not reject the hypothesis of normality of residuals with Jarque-Bera statistics and check the stability condition of the VAR, finding that all eigenvalues lie comfortably inside the unit circle.

Figure 2 shows the effects of civilian spending on the endogenous variables in Equation (2). In order to derive the 5th and 95th percentiles of the impulse response distribution in the graphs, error bands are computed by Monte Carlo simulations assuming normality in the parameter distribution. Accordingly, we construct t-tests based on 10,000 different responses generated by simulations and check whether the point estimates of the mean impulse responses are statistically different from zero. The responses of the five variables are expressed by multiplying the estimated parameters of the VAR by the sample average share of civilian spending in GDP.

We note that civilian spending (graph a) increases significantly and does not display a large persistence. In contrast to military spending shock, the pattern of persistence decreases with a half-life of about two years.

The response of the budget deficit variable (graph b) indicates a contrasting pattern: although it starts positively, it decreases and remains significantly negative, suggesting that unexpected civilian expenditure is financed by an increase in the taxation rate. We observe a positive response for disposable income (graph c) for the time-length considered. This result is in line with the prediction of the new Keynesian models, where the low persistence of civilian spending shock along with constraints in asset market participation reduces the wealth effect on Ricardian households.

As predicted by the new Keynesian models, real wage (graphs d) shows a positive and persistent response to a unitary shock of civilian spending. Most interestingly, the effect of a civilian expenditure shock on consumption is shown to be significant for a large timespan, persistently above zero (graph e). As we can observe, the response of consumption follows that of disposable income.

Figure 2 in here

Figure 3 displays the IRFs obtained from the VAR expressed in Equation (3) as a response to a positive shock in military spending. Defense expenditure response (graph a) rises significantly, showing a higher persistence with respect to the civilian shock. From the patterns of IRFs, we estimate that half-life period is above eight years. Graph b) pertains to the estimated response of the budget deficit variable, reproducing the evidence that, in the US, the defense sector is largely financed by budget deficits. The response of disposable income is negative (graph c); this effect is driven by the high persistence of military spending shock that strengthens the wealth effect on

Ricardian households. The point estimates shown in the IRFs indicate that the real wage decreases in response to the military spending shock (graph d). Interestingly, as found in the neoclassical literature, the pattern of consumption also decreases its impact (graph e), and the point estimates reveal that the shock may produce a significant effect. The consumption follows the pattern of the real disposable income response.

Figure 3 in here

Following the recent literature investigating the stimulative effects of fiscal actions (Drautzburg & Uhlig, 2015; Leeper, Traum & Walker, 2015; Canzoneri et al., 2016), we test the estimated impact multipliers on consumption. In particular, the impact multiplier on consumption measures the change in the level of consumption k periods ahead in response to a change in the fiscal variable of interest given by ΔF_t at time t[14]:

$$\text{Impact multiplier } k \text{ periods ahead} = \left(\frac{\Delta C_{t+k}}{\Delta F_t}\right) \tag{4}$$

thus the civilian spending impact multiplier is given by $\frac{\Delta C_{t+k}}{\Delta NM_t}$ and the military spending the impact multiplier is given by $\frac{\Delta C_{t+k}}{\Delta M_t}$. Table I shows the

[14]For example, the civilian spending multiplier is computed as follows, $\frac{\Delta C_{t+k}}{\Delta NM_t} = \frac{\%\Delta C_{t+k}}{\%\Delta NM_t}\frac{C}{NM}$, where C and NM are the steady state values of consumption and civilian expenditure, respectively. In particular, C and NM are obtained as the average values the real non-military expenditure and the real private consumption over the period 1960:Q1−2013:Q4, respectively.

results for the estimated impact multipliers on consumption. Particularly interesting for our study is the fact that positive multipliers on consumption of civilian expenditure, for the 1st, the 4th, the 8th and the 12th quarter, are 0.19, 0.56, 0.82 and 0.89, respectively. On the contrary (as expected from the point estimates), consumption multipliers are negative for military expenditure for the same quarters, between −0.10, −0.19, −0.23 and −0.26, respectively. Confidence intervals of these government expenditures at 95% also indicate a statistical significance of separate consumption multipliers, emphasizing important differences in the IRFs responses of military and civilian expenditures shocks on private consumption. As a robustness check, we also computed the civilian and military impact multipliers on output.[15]

Overall, our findings related to civilian spending are in line with the results by Ricco & Ellahie (2012). In particular, we provide evidence that increases in the non-military component positively influence the US GDP. Moreover, we confirm the predictions of two papers that have analyzed the impact of military spending on the macroeconomy. First, as in Nincic & Cusack (1979), we find that private consumption falls in response to military spending increases. Second, as in Barker, Dunne & Smith (1991), we show the negative impact of defense expenditure on both consumption and GDP.

Table I in here

[15]Since in this paper we focus on the effects on private consumption, we report these results in the Online appendix.

Pre- and post-Great Moderation: Subsample estimates

In this section, we compare the different impacts of civilian and military spending for two subsamples in order to check the robustness of our empirical analysis. Our sample choice reflects the well-established hypothesis of a structural break in the early 1980s (see, among others, Smets & Wouters, 2007; Bilbiie, Meier & Muller, 2008). In particular, we assume that the first sample period, the so-called "Great Inflation", ends in 1979:Q2, namely, the beginning of the Volcker chairmanship.[16] The second subsample starts in 1983:Q1 and corresponds to the more recent period of the "Great Moderation" in which inflation was relatively low and stable. This sample split captures the general changes in the US business cycle dynamics. Therefore, we estimate our civilian and military VARs for the two samples: 1960:Q1−1979:Q2 (S1) and 1983:Q1−2013:Q4 (S2). In the Online appendix, Figures E.2 and E.3 show the estimated IRFs for both the subsamples that we obtained applying the same technique as above.

Firstly, we observe that the persistence of the civilian shock is higher in S2 than in S1. Moreover, government budget deficit falls following this shock in both the subsamples. This pattern confirms that, historically, civilian expenditure has been financed through increases in taxation. Disposable income and real wage responses are significantly positive in S1 but not in S2. Interestingly, we find an evident "crowding-in" effect on private consumption

[16] With the term "Great Inflation" we refer to the period that lasted nearly two decades in which there were four economic recessions, two severe energy shortages, and the unprecedented peacetime implementation of wage and price controls.

in S1, whereas the response is not significant in S2. Accordingly, these results confirm that the differences in the persistence of the civilian shock in S1 and S2 crucially influence the response of private consumption.

Turning to the effects of military spending, we find that the military shock is more persistent in S2 than S1. Moreover, the responses of the US macroeconomic aggregates are negligible and not significant in the pre-1980 sample. On the contrary, the responses of S2 are mostly significant for an extended period. An increase in military spending induces a rise in the government budget deficit. This result confirms the estimated finding of the overall sample, namely, military spending is financed through the increase of budget deficit. Both disposable income and real wage show a negative response to an increase in military expenditure. As a consequence, private consumption falls after the shock.

Finally, we computed the consumption multipliers for both subsamples (Table II). In general, we find that the transmission mechanisms for the different shocks of fiscal components have changed over time. With regard to civilian spending, the stronger persistence of the shock in S2 with respect to S1 implies that the estimated multipliers are systematically higher in the pre-1980 sample. Turning to military expenditure, the lower persistence of the shock in the "Great Inflation" period induces slightly positive consumption multipliers for all the quarters considered.[17]

[17] In the Online appendix, we show that the results for the estimated multipliers on output mimic those of consumption.

Table II in here

Theoretical model and calibration

Our theoretical framework is fully consistent with the empirical strategy of the previous section. Indeed, we adopt a solution of our DSGE model, which implies that the several variables are expressed as their respective log deviations from the model steady state. Therefore, an unanticipated shock to civilian (or military) spending causes the temporary change of any given variable of our model before returning to its steady state. Accordingly, this interpretation of civilian and military shocks fits consistently with the results of the impulse response analysis of our estimated structural VARs. In what follows, we briefly describe the key features of our model, which follows the framework of Gali, Lopez-Salido & Valles (2007).[18] In particular, the model consists of an economy in which households are divided into Ricardians and non-Ricardians.

As regards labor market structure, it is assumed that there is an economy-wide union setting wages in a centralized manner. Hence, hours worked are not chosen optimally by households, but are determined by firms, given the wage set by the union. The economy produces a single final good and a continuum of intermediate goods. The aggregate production function includes

[18] The Online appendix gives a more detailed description of the model and its log-linearized conditions.

both capital and labor inputs. The total factor productivity is assumed to follow a first-order autoregressive process. The final goods sector is perfectly competitive and is consumed by households.

There is monopolistic competition in the markets for intermediate goods, each of which is produced by a single firm. Moreover, we assume that intermediate goods producer faces restrictions in the price setting process, as in Calvo (1983). The model encompasses a monetary authority that sets its policy instrument, the nominal interest rate, according to a generalized Taylor (1993) rule.

Turning to the fiscal sector, we assume that the government finances its public spending by issuing bonds and raising lump-sum taxes. Moreover, government purchases are separated into civilian and military components. Accordingly, we assume a fiscal policy rule that includes two different public spending components.[19] Civilian and military expenditures evolve exogenously, following to two distinct first-order autoregressive processes. Indeed, we assume that the resources destined for civilian and military sectors are AR(1) processes in line with the dynamic responses of our VAR-based estimates.[20]

Finally, the goods market clearing condition requires that the final goods

[19] In particular, our fiscal policy rule is an extension of those commonly used in the literature (see, for example, Bohn, 1998; Gali, Lopez-Salido & Valles, 2007)

[20] Following Smets & Wouters (2007), in a previous version of this paper we included the Total Factor Productivity (TFP) in the government spending processes in order to account for the misspecification of the DSGE common trend. The results obtained in the two different versions are almost unchanged.

market is in equilibrium if production equals demand by total household consumption, aggregate private investment and total government spending.

We propose a model calibration with quarterly data starting from "standard" parameters extracted from new Keynesian literature. Table III summarizes their values and sources.

Table III in here

In what follows, we focus only on the parameters describing the fiscal sector which are estimated from our sample. In particular, the values of the responses of taxes to civilian (ϕ_{nm}) and military (ϕ_m) expenditures are obtained as the difference of the estimated effects of the VAR in civilian/military expenditures and the budget deficit. In line with the findings in the literature, the estimates for our sample are of ϕ_{nm}=0.16 and ϕ_m=0.18.

We also estimate the persistence parameters of civilian and military expenditures, ρ_{nm} and ρ_m, according to the procedure proposed by Marques (2005), in which the absence of mean reversion of a given series is measured by using the following statistic:

$$\rho = 1 - \frac{n}{t} \tag{5}$$

where n denotes for the number of times the series crosses the mean during a time interval with t observations. Monte Carlo simulations have shown the validity and consistency of this estimator in order to obtain this measure of persistence. Our VAR-based estimates indicate the lower persistence of civilian spending shock, whereas the higher persistence appears in the estimated patterns of military expenditure. By using the persistent estimator in Equation (5), after detrending the time-series of the fiscal components, we obtain $n = 40$ for civilian and $n = 15$ for military spending, such as we have $\rho_{nm} = 0.81$ and $\rho_m = 0.93$, respectively, for $t = 216$.[21]

Finally, we calibrate the parameter ϕ_b such that it is consistent with the necessary and sufficient condition for non-explosive deficit dynamics. Thus, we set ϕ_b equal to 0.1. In this regard, the value of the parameter indicating the response of taxes to budget deficit has been estimated by a large number of empirical works (see, among others, Bilbiie, Meier & Muller, 2008; Leeper, Plante & Traum, 2010). In our specific case, since our fiscal rule is very similar to that adopted by Gali, Lopez-Salido & Valles (2007), we chose a value that lies in the range of estimates provided by these authors.

Impulse response analysis of the simulated model

In this section, we present the impulse response analysis for the theoretical model described above. Our objective is to compare simulated IRFs with those obtained from the SVAR. We present the key figures of our analysis in detail in a supplementary online appendix and summarize those results

[21]These estimates are obtained from the same series used in the empirical section, i.e. NM_t and M_t are expressed as relative shares of GDP. Moreover, we detrend these series with the HP filter (smoothing parameter equal to 1,600).

below.

Implications for the model with heterogeneous fiscal policy shocks

We first discuss the implications of the model in the case of a positive civilian spending shock. In the Online appendix, Figure E.4 shows that the persistence of this shock is very low. Interestingly, this result confirms our empirical findings. In particular, the low persistence of civilian spending shock reduces the negative wealth effect on Ricardian agents. These perceive that the increase in the tax burden in present value terms is only temporary, and they do not significantly change their consumption level.

In addition, one year after the shock, the budget deficit becomes negative and remains persistently below zero for all the horizons considered. Thus, the reduction of the budget deficit moves further resources to consumption of Ricardian agents.

Real wages increase after the shock to civilian spending. This result can be explained by the substantial rise of labor demand, since the civilian spending shock causes an increase in the aggregate demand. Due to sticky prices, not all firms can adjust their prices after the shock. Firms that cannot change their prices are forced to change their production quantity. Thus, in order to increase their output, firms raise their demand for labor and the new equilibrium in the labor market implies a higher real wage. As a consequence, the disposable incomes of both non-Ricardians and Ricardians increases. Accordingly, we observe the so called "crowding-in" effect on total consumption spending. The higher disposable income of non-Ricardians induces a substantial increase in their consumption level, which leads to the rise of private consumption expenditure.

Turning to the effects of a rise in military spending, from Figure E.5 in the Online appendix, we note a high level of persistence of military expenditure in line with our estimated results. As a consequence, the negative wealth effect on Ricardian households is substantial. Indeed, these agents decide to postpone their consumption because they perceive that the increase in the tax burden will last for a long period.

The budget deficit expands after the shock. This result is in accordance with the idea that policy-makers in periods of uncertainty, such as wars or threat episodes, react for the conflict challenges and their uncertainty by developing preferences to postpone taxation to future generations. However, the increase of budget deficit further reduces the incentive of consumption in the Ricardian households that end up holding all the bonds issued by government.

The increase in military spending causes a reduction of real wage. This effect is mainly due to a positive shift of labor supply. Non-Ricardians choose to increase their hours worked because of the rise in the tax burden. Similarly, Ricardian households increase their labor supply for a given wage. The new equilibrium in the labor market implies a lower real wage. Therefore, we observe that the military spending shock reduces the disposable income of non-Ricardian and Ricardian households, inducing the "crowding-out" effect on consumption.

Robustness

In line with recent new Keynesian models, our theoretical framework includes several features that allow us to analyze several transmission channels through which civilian and military shocks affect private consumption. First, we focus on the implications of the different persistence of each fiscal shock. Second, we assess the importance of distinct financing mechanisms of public spending. Third, we study the impact of different fiscal shocks in the presence of price rigidities and heterogeneous households (Ricardians and non-Ricardians). Finally, we analyze the impact of different monetary policy approaches in response to distinct government shocks.

Different persistence of shocks and financing mechanisms

We begin by describing the behavior of private consumption in response to different persistence values of civilian spending shocks.[22] The "crowding-in" effect clearly emerges in the benchmark case ($\rho_{nm} = 0.81$), while if we increase the value of ρ_{nm} to 0.93, we observe a small decrease in private consumption expenditure. Accordingly, when we fix ρ_{nm} equal to 0.99 we obtain a large "crowding-out" effect on consumption.

[22] See Figure E.6 in the Online appendix.

Focusing on military spending, we consider the following exercise. We start by fixing ρ_m equal to 0.93. We then decrease it to 0.81 and, finally, we reset it to 0.99. Private consumption responds negatively in the presence of high shock persistence, whereas it increases when ρ_m is low.

A crucial aspect of our impulse response analysis is also related to the different financing mechanisms of civilian and military spending. As we explained before, in our benchmark calibration, we consider the responses of taxes to civilian (ϕ_{nm}) and military (ϕ_m) expenditures equal to 0.16 and 0.18, respectively. As regards the response of taxes to budget deficit (ϕ_b), we assume it equal to 0.1. In the following exercise, we change the values of the parameters ϕ_{nm} and ϕ_m, keeping fixed the parameterization for ϕ_b. As we show in Figure E.7 in the Online appendix, our objective is to assess the different reactions of total private consumption to these changes.

We start by analyzing the case of a positive shock to civilian expenditure. We assume three different values for ϕ_{nm}, that are 0.01, 0.16 (benchmark case) and 0.99. The "crowding-in" effect on private consumption remains unchanged in all three cases. However, the magnitude of the rise in total consumption expenditure changes substantially. Interestingly, when the response of taxes to civilian spending is particularly high, the increase of private consumption is modest compared with the case of a low ϕ_{nm}. In order to explain the last result, we need to take into account for the negative wealth effect on Ricardian households caused by the increase of the tax burden. The high response of taxes to a rise in civilian spending generates a substantial wealth effect on Ricardian agents, postponing their current consumption. On the contrary, if ϕ_{nm} is low, the increase in tax burden is small and Ricardian households do not significantly change their level of consumption. As a consequence, the "crowding-in" effect is larger.

Turning to the military spending shock, the "crowding-out" reduces if the value of ϕ_m increases. A low value of ϕ_m implies a sharp increase of the budget deficit in response to the military spending shock. This siphons further resources away from potential consumption of Ricardian households because they end up holding all the government bonds. On the contrary, with an high value of ϕ_m, the increase of budget deficit is less accentuated. The latter, in turn, reduces the "crowding-out" effect on private consumption.

Heterogeneous households, price rigidities and monetary policy

Although the distinction between Ricardian and non-Ricardian households is crucial for our setup, it is not the only difference between our framework and standard Real Business Cycle (RBC) models assessing the effects of government shocks on private consumption. Indeed, price rigidities and monetary policy play an important role in the response of private consumption to fiscal shocks. In what follows, we provide several robustness checks in order to clarify these aspects. In order to save space we show the IRFs related to these sensitivity analyses in the Online appendix (Figures E.8−E.10).

We begin by analyzing the dynamic responses of private consumption to positive civilian and military spending shocks under our baseline calibration and with different parameterizations of λ. The main results of our analysis do not change if we assume a lower value of λ equal to 0.3. The last result confirms that our model is able to predict the "crowding-in" effect without the presence of a substantial share of non-Ricardian consumers. On the contrary, under the standard assumption of RBC models (accounting only for Ricardian households), our model generates a negative response of private consumption to the increase in civilian spending. Evidently, this is in sharp contrast with the empirical evidence we have shown above.

Focusing on price rigidities and assuming lower values of the Calvo price probability (0 and 0.3, respectively), we find that private consumption falls in response to a rise in civilian expenditure. In the case of military spending, moving from our new Keynesian benchmark toward models with neoclassical characteristics, we find that the negative response of consumption is strengthened. Interestingly, the magnitude of the negative impact is in accordance with the findings in the defense economics literature using partial equilibrium specification.[23]

Monetary policy is also a relevant transmission channel of government spending shocks on private consumption. In particular, we assume the case in which all the model parameters have the same values as in Table III except for the policy rate response to inflation (ϕ_π) that varies from 1.5 (benchmark case) to 5 and 10. A high value of (ϕ_π) implies a more aggressive monetary policy. In the presence of an aggressive monetary policy, the effect

[23] See, for example, Pieroni (2009).

of an increase in civilian spending on private consumption is negative. In this case, Ricardian households increase their labor supply as a consequence of the intertemporal substitution effect. This occurs when a rise in inflation triggers an increase in the real interest rate, thus providing incentives for Ricardians to postpone consumption. On the contrary, a less aggressive monetary policy (low value of ϕ_π) implies a lower real interest rate and thereby weakens Ricardians incentives to postpone consumption. Finally, as expected, higher values (ϕ_π) strengthen the "crowding-out" effect in the case of military spending shocks.

Conclusions

This paper analyzed the effects of US fiscal policy shocks on private consumption over the period 1960:Q1−2013:Q4. The contribution of our analysis is that we distinguished between civilian and military spending shocks. Our empirical approach allowed us to assess several transmission channels through which these different government components affect the US economy. In this regard, we found that civilian spending shocks are less persistent than military ones. Moreover, our VAR estimates provided evidence that military expenditure is usually financed through increases in government deficit. As a consequence, our impulse response analysis showed that civilian spending shocks have a largely positive effect on private consumption. On the contrary, a negative impact was found between military spending shocks and consumption responses. We also assessed the effects of civilian and military shocks on the US economy for two subsamples corresponding to the "Great Inflation" and the "Great Moderation" periods, respectively. Our results indicated that the transmission channels of civilian and military spending shocks have changed over time. In particular, the persistence of civilian shocks is larger in the post-1980 period implying less significant effects on the several macroeconomic aggregates. On the contrary, the negative effects of military spending shocks are stronger in the "Great Moderation" period.

As a second step of our analysis, we adopted a new Keynesian DSGE model in order to replicate our empirical findings. In this regard, focusing on increases in military spending, we were able to simulate the negative consumption response of the VAR estimates reproducing the same main transmission channels. First, the high persistence of this expenditure increases the negative income effect on Ricardian households. Thus, these agents reduce drastically their consumption implying the "crowding-out" effect. Second, a positive response of the budget deficit, through which military spending is generally financed, leads to a further reduction in the consumption of Ricardian agents that prefer to hold government bonds. Our model also predicts that the lower persistence of civilian expenditure from its own shocks reduces the negative wealth effect associated to Ricardian agents. When this effect is associated with a strong rise in the real wage, we observe a positive response of aggregate consumption. Indeed, a high real wage stimulates the consumption of non-Ricardians that dominates the fall in consumption of Ricardian households.

Although we believe that this analysis is a useful contribution to more effective management of fiscal policy tools on the expenditure side, it does leave several interesting questions open for future research. In particular, issues in estimating the DSGE model parameters have received increasing interest in the macroeconometric literature. Accordingly, a theoretical framework that includes Bayesian estimation provides promising opportunities for future research.

Replication data

All material necessary for reproducing the analysis, along with the Online appendix, can be found at http://www.prio.org/jpr/datasets.

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Biographical statement

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Table I. Estimated fiscal policy effects (civilian and military spending) on consumption

	Estimated fiscal policy multipliers on private consumption			
Quarters	1	4	8	12
Civilian spending	0.19 [0.16/0.22]	0.56 [0.52/0.59]	0.82 [0.77/0.88]	0.89 [0.84/0.94]
Military spending	-0.10 [-0.08/-0.12]	-0.19 [-0.16/-0.21]	-0.23 [-0.20/-0.27]	-0.26 [-0.22/-0.29]

Results from cumulated IRFs. 95% confidence intervals are listed in brackets.

Table II. Subsample estimates, fiscal policy effects (civilian and military spending) on consumption

	S1: Estimated fiscal policy multipliers on private consumption			
Quarters	1	4	8	12
Civilian spending	0.97 [0.92/1.03]	1.71 [1.62/1.79]	1.83 [1.75/1.91]	1.38 [1.31/1.45]
Military spending	0.14 [0.12/0.17]	0.13 [0.09/0.18]	0.12 [0.07/0.18]	0.06 [0.00/0.12]
	S2: Estimated fiscal policy multipliers on private consumption			
Quarters	1	4	8	12
Civilian spending	-0.23 [-0.20/-0.25]	0.02 [-0.03/0.06]	0.35 [0.21/0.49]	0.59 [0.52/0.65]
Military spending	-0.27 [-0.23/-0.30]	-0.63 [-0.58/-0.67]	-0.98 [-0.92/-1.03]	-1.24 [-1.17/-1.30]

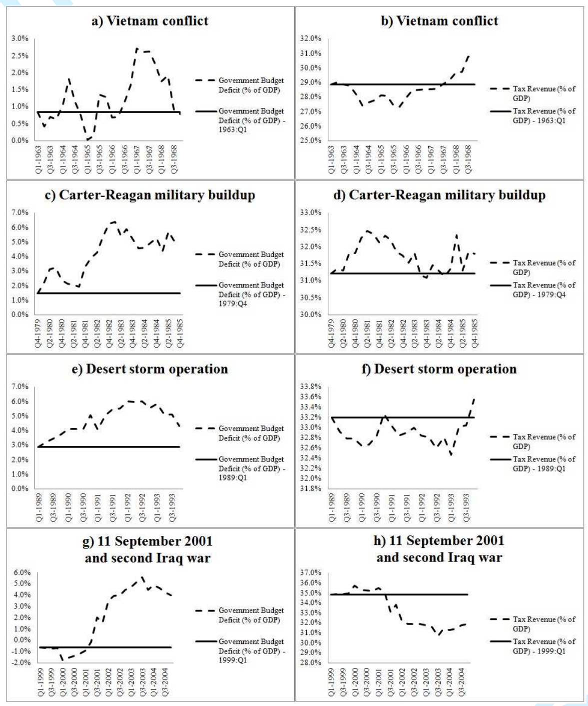
Results from cumulated IRFs. 95% confidence intervals are listed in brackets.

Table III. Calibrated parameters of the model

Parameter	Symbol	Value	Target/Source
Discount factor	β	0.99	Steady state real interest rate: 0.04
El. of inv. wrt capital stock value	η	1	King & Watson (1996)
Capital depreciation rate	δ	0.025	Annual depreciation on capital: 0.10
Fraction of non-Ricardians	λ	0.5	Gali, Lopez-Salido & Valles (2007)
Capital share in the prod. fun.	α	1/3	Labor share: 70%
El. of wages wrt hours worked	φ	0.2	Rotemberg & Woodford (1999)
Price mark-up parameter	μ^p	0.2	Gali, Lopez-Salido & Valles (2007)
Calvo price probability	θ	0.65	Average price duration: 4 quarters
Policy rate response to inflation	ϕ_π	1.5	Clarida, Gali & Gertler (2000)
Response of taxes to civilian spending	ϕ_{nm}	0.16	Estimates from our data sample
Response of taxes to military spending	ϕ_m	0.18	Estimates from our data sample
Response of taxes to budget deficit	ϕ_b	0.1	Calibrated
Persistence of civilian spending	ρ_{nm}	0.81	Estimates from our sample
Persistence of military spending	ρ_m	0.93	Estimates from our sample

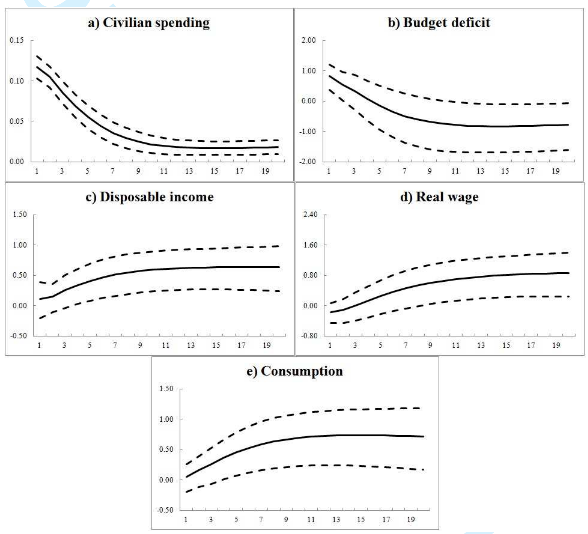
Calibration of the parameters based on quarterly data.

Figure 1. Financing mechanisms in the US for military conflicts and episodes



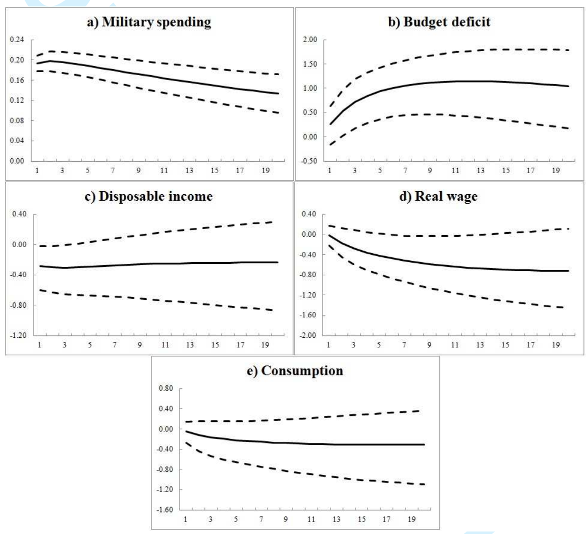
Government budget deficit and tax revenues as percentages of GDP are taken from OECD Economic Outlook, No. 90. In particular, government budget deficit is obtained as the difference between total disbursements and total receipts of general government.

Figure 2. Response of the VAR model to a civilian spending shock

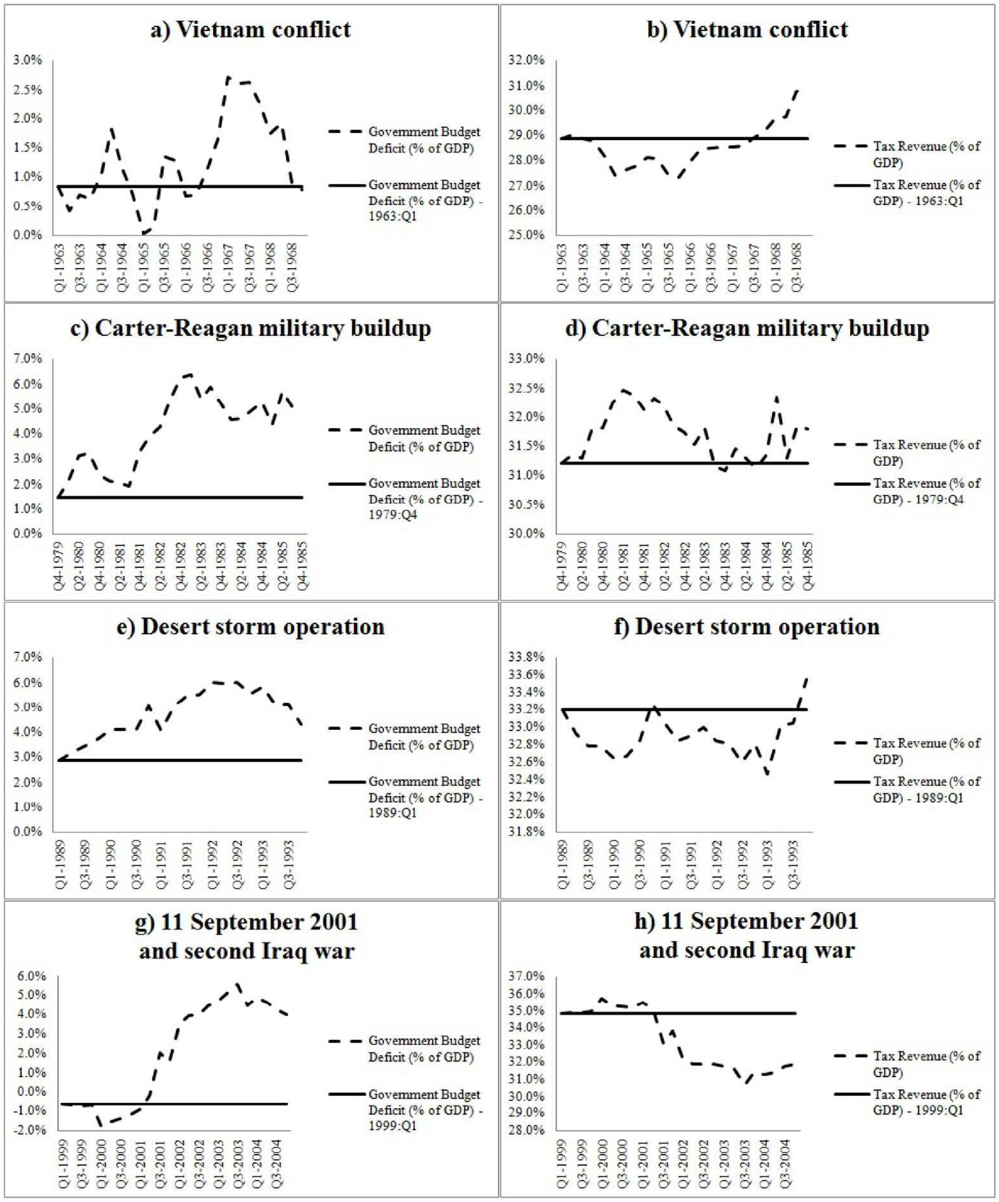


Estimated impulse responses to a civilian spending shock in SVAR. Sample period 1960:Q1−2013:Q4. Vertical axis indicates deviations from unshocked path. Horizontal axis: quarters after shock. Confidence intervals at the usual 95% significant level based on 10,000 Monte Carlo replications.

Figure 3. Response of the VAR model to a military spending shock



Estimated impulse responses to a military spending shock in SVAR. Sample period 1960:Q1−2013:Q4. Vertical axis indicates deviations from unshocked path. Horizontal axis: quarters after shock. Confidence intervals at the usual 95% significant level based on 10,000 Monte Carlo replications.



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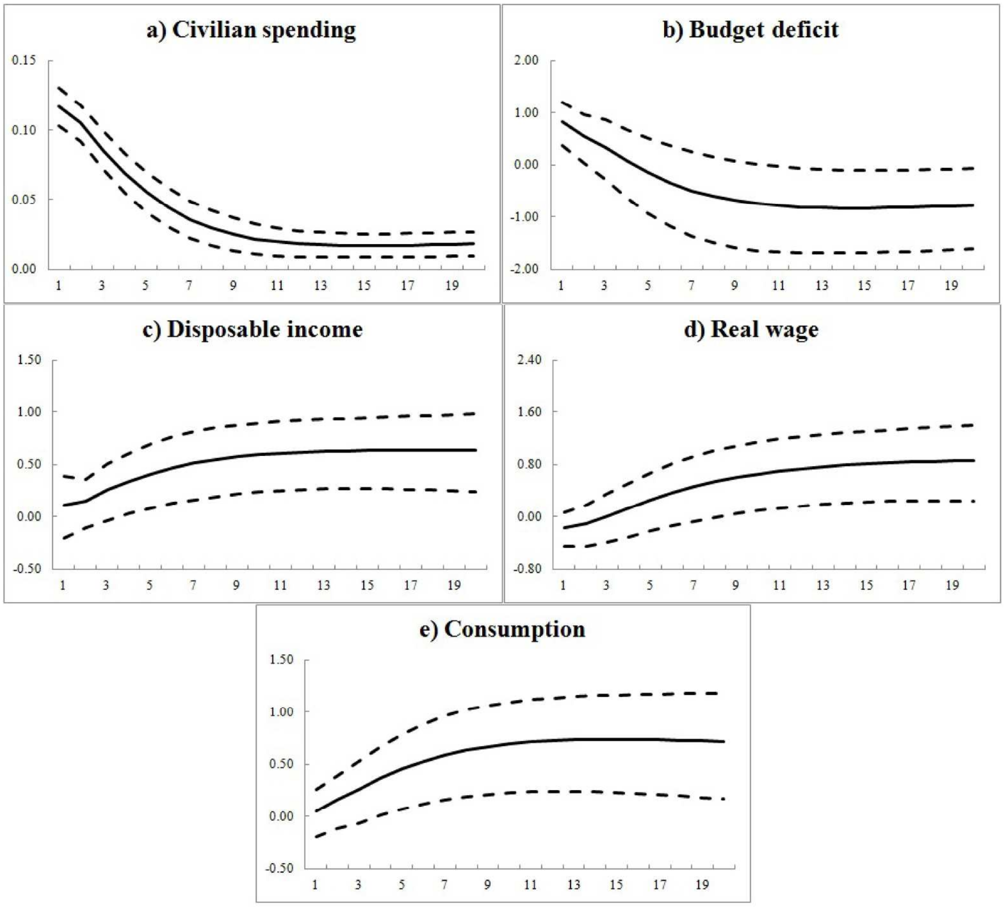

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Appendices to: The effects of military and non-military government expenditures on private consumption

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November 2016

Contents

1. Appendix A: Data sources and construction

As we described in the main body of the paper, the data are quarterly and the VAR model is estimated for the sample period 1960:Q1−2013:Q4. In this appendix, we provide the original data sources and construction methods of the time series used in our analysis.

Real Private Consumption. It is obtained from the series of Private Final Consumption Expenditure, value, appropriation account (OECD Economic Outlook, No. 90 - OLIS version). The original series is deflated by the Gross Domestic Product Deflator, market prices (OECD Economic Outlook, No. 90 - OLIS version), divided by the Working-Age Population (OECD Economic Outlook, No. 90 - OLIS version) and expressed in log terms.

Real Wage. It is obtained from the series of Compensation of Employees, value (OECD Economic Outlook, No. 90 - OLIS version). The original series is deflated by the Gross Domestic Product Deflator, market prices (OECD Economic Outlook, No. 90 - OLIS version), divided by the Working-Age Population (OECD Economic Outlook, No. 90 - OLIS version) and expressed in log terms.

Real Disposable Income. It is obtained from the series of Real Disposable Personal Income, billions of chained 2009 dollars, quarterly, seasonally adjusted annual rate (Federal Reserve Bank of St. Louis). The original series is divided by the Working-Age Population (OECD Economic Outlook, No. 90 - OLIS version) and expressed in log terms.

Government Budget Deficit. It is obtained as the difference between Gross Government Fixed Capital Formation, value (OECD Economic Outlook, No. 90 - OLIS version) and Government Saving, value (OECD Economic Outlook, No. 90 - OLIS version). Then, we express this series as share of nominal GDP using the Gross Domestic Product, value, market prices (OECD Economic Outlook, No. 90 - OLIS version).

Civilian Spending. We take the original series of Government Consumption Expenditures and Gross Investment, billions of dollars, seasonally adjusted at annual rates (Bureau of Economic Analysis) and we deflate it by the Government Consumption Expenditures and Gross Investment, Deflator, index number, 2009 = 100, seasonally adjusted (Bureau of Economic Analysis). Similarly, we take the original series of National Defense, billions of dollars, seasonally adjusted at annual rates (Bureau of Economic Analysis) and we deflate it by the National Defense, Deflator, index number, 2009 = 100, seasonally adjusted (Bureau of Economic Analysis). Accordingly, we subtract the series of Real National Defense to

Real Government Consumption Expenditures and Gross Investment. Finally, we express this series as share of Real GDP, where the original series of Gross Domestic Product, billions of dollars, seasonally adjusted at annual rates (Bureau of Economic Analysis) is deflated by Gross Domestic Product Deflator, index number, 2009 = 100, seasonally adjusted (Bureau of Economic Analysis).

Military Spending. We take the original series of National Defense, billions of dollars, seasonally adjusted at annual rates (Bureau of Economic Analysis) and we deflate it by the National Defense, Deflator, index number, 2009 = 100, seasonally adjusted (Bureau of Economic Analysis). Then, we express this series as share of Real GDP, where the original series of Gross Domestic Product, billions of dollars, seasonally adjusted at annual rates (Bureau of Economic Analysis) is deflated by Gross Domestic Product Deflator, index number, 2009 = 100, seasonally adjusted (Bureau of Economic Analysis).

Real GDP. It is obtained from the series of Gross Domestic Product, value, market prices (OECD Economic Outlook, No. 90 - OLIS version). The original series is deflated by the Gross Domestic Product Deflator, market prices (OECD Economic Outlook, No. 90 - OLIS version), divided by the Working-Age Population (OECD Economic Outlook, No. 90 - OLIS version) and expressed in log terms.

2. Appendix B: Model solution

As we explained in the main text, our model is in line with the framework of Galì et al. (2007). In what follows, we present the several maximization problems.

2.1. *Ricardian households*

A typical household of this type maximizes:

$$\max E_t \sum_{t=o}^{\infty} \beta^t U\left(C_t^r, N_t^r\right) \quad \text{(Eq. A1)}$$

$$\text{with} \quad : \quad 0 < \beta < 1$$

$$\text{where} \quad : \quad U\left(C_t^r, N_t^r\right) = \log C_t^r - \frac{\left(N_t^r\right)^{1+\varphi}}{1+\varphi} \quad \text{(Eq. A2)}$$

$$\text{with} \quad : \quad \varphi \geq 0$$

where E_t is the conditional expectation operator, $U(\cdot)$ the life-time utility function and C_t^r and N_t^r denote time-t consumption and hours worked, respectively. The discount factor is $\beta \in (0,1)$, and the elasticity of wages with respect to hours is $\varphi \geq 0$.

Ricardian households face the following budget constraint:

$$P_t\left(C_t^r + I_t^r\right) + R_t^{-1} B_{t+1}^r = W_t P_t N_t^r + R_t^k P_t K_t^r + B_t^r + D_t^r - P_t T_t^r \quad \text{(Eq. A3)}$$

and the capital accumulation equation:

$$K_{t+1}^r = (1-\delta) K_t^r + \phi\left(\frac{I_t^r}{K_t^r}\right) K_t^r \quad \text{(Eq. A4)}$$

$$\text{where} \quad : \quad \phi'\left(\frac{I_t^r}{K_t^r}\right) > 0$$

$$\text{and} \quad : \quad \phi''\left(\frac{I_t^r}{K_t^r}\right) \leq 0$$

$$\text{and} \quad : \quad \phi'(\delta) = 1$$

$$\text{finally} \quad : \quad \phi(\delta) = \delta$$

We denote with T_t^r the lump sum taxes (or transfers, if negative) paid by these consumers to government, while D_t^r are dividends from ownership of firms. The variable B_{t+1}^r denotes the quantity of one-period bonds purchased by these households at time t. Also, P_t denotes the price level and W_t denotes the real wage rate. R_t denotes the one-period nominal rate of interest that pays off in period t. K_t^r represents the capital holding and R_t^k its real rental cost. Finally, I_t^r indicates investment expenditures in real terms. Capital adjustment costs are introduced through the term $\phi\left(\frac{I_t^r}{K_t^r}\right)K_t^r$, which determines the change in the capital stock induced by investment spending.

The lagrangian of this problem is:

$$\mathcal{L} = E_t \sum_{t=o}^{\infty} \beta^t \left\{ \begin{array}{c} \left[\log C_t^r - \frac{(N_t^r)^{1+\varphi}}{1+\varphi}\right] + \\ \lambda_t \left[\begin{array}{c} P_t\left(C_t^r + I_t^r\right) + R_t^{-1} B_{t+1}^r \\ -W_t P_t N_t^r - R_t^k P_t K_t^r - B_t^r - D_t^r + P_t T_t^r \end{array} \right] + \\ \tau_t \left[(1-\delta) K_t^r + \phi\left(\frac{I_t^r}{K_t^r}\right) K_t^r - K_{t+1}^r \right] \end{array} \right\}$$

The first order conditions for C_t^r and L_t^r are:

$$\frac{\partial \mathcal{L}}{\partial C_t^r} = 0 \Rightarrow \lambda_t = -\frac{1}{C_t^r}\frac{1}{P_t} \qquad \text{(Eq. A5)}$$

$$\frac{\partial \mathcal{L}}{\partial N_t^r} = 0 \Rightarrow \left(N_t^r\right)^{\varphi} = -\lambda_t W_t P_t \qquad \text{(Eq. A6)}$$

We show in Appendix C the details of the non competitive labor market structure, i.e. under the case of a non-competitive labor market condition.

The FOC for B_{t+1}^r is:

$$\frac{\partial \mathcal{L}}{\partial B_{t+1}^r} = 0 \Rightarrow \lambda_t \frac{1}{R_t} = \lambda_{t+1}\beta \qquad \text{(Eq. A8)}$$

putting (Eq. A5) into (Eq. A8) we obtain the Euler equation:

$$1 = R_t E_t\left[\Lambda_{t,t+1}\frac{P_t}{P_{t+1}}\right] \qquad \text{(Eq. A9)}$$

6

where the stochastic discount factor is:

$$\Lambda_{t,t+k} = \beta^k \left(\frac{C^r_{t+k}}{C^r_t} \right)^{-1} \quad \text{(Eq. A10)}$$

The FOC for K^r_{t+1} is:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial K^r_{t+1}} &= 0 \Rightarrow \\ \beta^{t+1}\tau_{t+1} \left[\begin{array}{c} (1-\delta) \\ -\phi' \left(\frac{I^r_{t+1}}{K^r_{t+1}} \right) \frac{I^r_{t+1}}{\left(K^r_{t+1}\right)^2} K^r_{t+1} \\ +\phi \left(\frac{I^r_{t+1}}{K^r_{t+1}} \right) \end{array} \right] &= \left[\begin{array}{c} \beta^t \tau_t + \\ \beta^{t+1}\lambda_{t+1} \cdot \\ R^k_{t+1} P_{t+1} \end{array} \right] \end{aligned} \quad \text{(Eq. A11)}$$

The FOC for I^r_{t+1} is:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial I^r_{t+1}} &= 0 \Rightarrow \\ \tau_t &= -\frac{1}{\phi' \left(\frac{I^r_t}{K^r_t} \right)} (\lambda_t P_t) \end{aligned} \quad \text{(Eq. A12)}$$

putting (Eq. A12) into (Eq. A11) we obtain the Tobin's Q equation:

$$Q_t = E_t \left(\Lambda_{t,t+1} \left\{ R^k_{t+1} + Q_{t+1} \left[\begin{array}{c} (1-\delta) \\ -\phi' \left(\frac{I^r_{t+1}}{K^r_{t+1}} \right) \frac{I^r_{t+1}}{K^r_{t+1}} \\ +\phi \left(\frac{I^r_{t+1}}{K^r_{t+1}} \right) \end{array} \right] \right\} \right) \quad \text{(Eq. A13)}$$

where:

$$Q_t = \frac{1}{\phi' \left(\frac{I^r_t}{K^r_t} \right)} \quad \text{(Eq. A14)}$$

2.2. *Non-Ricardian households*

A typical household of this type seeks to maximize:

$$\max U \left(C^{nr}_t, N^{nr}_t \right) \quad \text{(Eq. A15)}$$

$$\text{where} \quad : \quad U \left(C^{nr}_t, N^{nr}_t \right) = \log C^{nr}_t - \frac{\left(N^{nr}_t\right)^{1+\varphi}}{1+\varphi} \quad \text{(Eq. A16)}$$

subject to the budget constraint:

$$P_t C_t^{nr} = W_t P_t N_t^{nr} - P_t T_t^{nr}$$

The last expression, implies that non-ricardian households consume their disposable income:

$$C_t^r = W_t N_t^r - T_t^r \qquad \text{(Eq. A17)}$$

The Lagrangian associated to this problem is:

$$\mathcal{L} = \left[\log C_t^{nr} - \frac{\left(N_t^{nr}\right)^{1+\varphi}}{1+\varphi}\right] + \lambda_t \left[P_t C_t^{nr} - W_t P_t N_t^{nr} + P_t T_t^{nr}\right]$$

the first order conditions for C_t^{nr} and N_t^{nr} are:

$$\frac{\partial \mathcal{L}}{C_t^{nr}} = 0 \Rightarrow \lambda_t = -\frac{1}{C_t^{nr}} \frac{1}{P_t} \qquad \text{(Eq. A18)}$$

$$\frac{\partial \mathcal{L}}{N_t^{nr}} = 0 \Rightarrow \lambda_t W_t P_t = -\left(N_t^{nr}\right)^{\varphi} \qquad \text{(Eq. A19)}$$

Alternatively, when the wage is set by a union, hours are determined by firms' labor demand. We refer the reader to the subsequent discussion.

2.3. *Final good firms*

The final good, Y_t, is produced by competitive firms using the technology:

$$Y_t = \left(\int_0^1 X_t\left(j\right)^{\frac{\varepsilon_p - 1}{\varepsilon_p}} dj \right)^{\frac{\varepsilon_p}{\varepsilon_p - 1}} \qquad \text{(Eq. A21)}$$

where the constant elasticity of substitution is $\varepsilon_p > 1$, and $X_t\left(j\right)$, $j \in [0, 1]$, denotes the intermediate good j.

Profit maximization, taking as given the final goods price P_t and the prices for the intermediate goods $P_t(j)$, all $j \in [0,1]$, yields the set of demand schedules:

$$\max_{X_t(j)} P_t Y_t - \int_0^1 P_t(j) X_t(j) \, dj \qquad \text{(Eq. A22)}$$

In particular, profit maximization implies the following first order condition for $X_t(j)$:

$$X_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\varepsilon_p} Y_t \qquad \text{(Eq. A23)}$$

where $P_t(j)$ denotes the price of intermediate good j and P_t is the price of the homogeneous final good. Perfect competition in the final goods market implies that the latter can be written as:

$$P_t = \left[\int_0^1 P_t(j)^{1-\varepsilon_p} \, dj \right]^{\frac{1}{1-\varepsilon_p}} \qquad \text{(Eq. A24)}$$

2.4. *Intermediate good firms*

Taking the production function for a typical intermediate good firm:

$$Y_t(j) = K_t(j)^{\alpha} N_t(j)^{1-\alpha} \qquad \text{(Eq. A25)}$$

where $N_t(j)$ and $K_t(j)$ denote, respectively, employment and capital used by the j^{th} intermediate firm, while α is the capital elasticity.

The maximization of real profits is thus given by:

$$\max_{K_t(j), N_t(j)} O_t(j) = \frac{P_t(j)}{P_t} Y_t(j) - R_t^k K_t(j) - W_t N_t(j) + \lambda_t(j) \left[K_t(j)^{\alpha} N_t(j)^{1-\alpha} - Y_t(j) \right]$$

The FOCs are:

$$\frac{\partial O_t(j)}{\partial N_t(j)} = 0 \Rightarrow (1-\alpha) \lambda_t(j) \left(\frac{K_t(j)}{N_t(j)} \right)^{\alpha} = W_t \qquad \text{(Eq. A26)}$$

and:

$$\frac{\partial O_t(j)}{\partial K_t(j)} = 0 \Rightarrow \alpha \lambda_t(j) \left(\frac{K_t(j)}{N_t(j)}\right)^{\alpha-1} = R_t^k \qquad \text{(Eq. A27)}$$

from (Eq. A26) and (Eq. A27):

$$\begin{aligned} \frac{W_t}{R_t^k} &= (1-\alpha)\lambda_t(j)\left(\frac{K_t(j)}{N_t(j)}\right)^{\alpha}\frac{1}{\alpha}\frac{1}{\lambda_t(j)}\left(\frac{K_t(j)}{N_t(j)}\right)^{1-\alpha} \Rightarrow \\ \frac{W_t}{R_t^k} &= \frac{1-\alpha}{\alpha}\left(\frac{K_t(j)}{N_t(j)}\right) \Rightarrow \\ \frac{K_t(j)}{N_t(j)} &= \frac{\alpha}{1-\alpha}\frac{W_t}{R_t^k} \qquad \text{(Eq. A28)} \end{aligned}$$

Real marginal cost is common to all firms and given as follows. From (Eq. A26) and (Eq. A27):

$$\begin{aligned} MC_t &= \Psi (W_t)^{1-\alpha}\left(R_t^k\right)^{\alpha} \qquad \text{(Eq. A29)} \\ \text{where} &: \Psi = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)} \end{aligned}$$

2.5. *Price setting*

A firm resetting its price in period t solves:

$$\max_{P_t^*} E_t \sum_{k=0}^{\infty} \theta^k \left\{\Lambda_{t,t+k} Y_{t,t+k}(j)\left(\frac{P_t^*}{P_{t+k}} - MC_{t+k}\right)\right\} \qquad \text{(Eq. A30)}$$

subject to the sequence of demand constraints:

$$Y_{t+k}(j) = X_{t+k}(j) = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\varepsilon_p} Y_{t+k}$$

The FOC is the following:

$$\begin{aligned} E_t \sum_{k=0}^{\infty} \theta^k \left\{\Lambda_{t,t+k} Y_{t+k}(j)\left(\frac{P_t^*}{P_{t+k}} - \mu^p MC_{t+k}\right)\right\} &= 0 \qquad \text{(Eq. A31)} \\ \text{where} &: \mu^p \equiv \frac{\varepsilon_p}{\varepsilon_p - 1} \end{aligned}$$

Finally, the law of motion of aggregate price is given by:

$$P_t = \left[\theta P_{t-1}^{1-\varepsilon_p} + (1-\theta)\left(P_t^*\right)^{1-\varepsilon_p}\right]^{\frac{1}{1-\varepsilon_p}} \qquad \text{(Eq. A32)}$$

2.6. *Monetary policy*

We assume that monetary authority sets the nominal interest rate, $r_t \equiv R_t - 1$, following the rule:

$$r_t = r + \phi_\pi \pi_t \qquad \text{(Eq. A33)}$$

where r is the steady state level of interest rate and π_t denotes the time-t rate of inflation. According to equation (Eq. A33), the central bank follows a particular case of the standard Taylor rule (1993). From expression (Eq. A33), we note that the so-called Taylor principle is satisfied if the coefficient related to the long run response of interest rate to inflation, ϕ_π, is bigger than one.

2.7. *Fiscal policy: Civilian and military expenditures*

The government budget constraints assume that to finance public spending, the government should issue bonds and raise lump-sum taxes. As one of the main aims of this paper, we separate government purchases into the components of expenditure of civilian (NM_t) and military (M_t) and, consequently, display a composite budget constraint as:

$$\begin{aligned} P_t T_t + R_t^{-1} B_{t+1} &= B_t + P_t \left(NM_t + M_t \right)_t \qquad \text{(Eq. A34)} \\ \text{where} &: T_t \equiv \lambda T_t^{nr} + (1-\lambda) T_t^r \end{aligned}$$

where T_t denotes the real taxes (lump sum) paid by (Ricardian and non-Ricardian) consumers to the government, and the variable B_{t+1} the quantity of one-period bonds purchased by households at time t. P_t denotes the price level. The last expression encompasses the sum of civilian and military components according to the additive principle.

Equation (Eq. A35) shows that linearization of the government budget constraint remains around the steady state, with zero debt and a balanced primary budget:

$$b_{t+1} = \frac{1}{\beta}\left(b_t + nm_t + m_t - t_t\right) \qquad \text{(Eq. A35)}$$

$$\text{where} \quad : \quad nm_t = \frac{NM_t - NM}{Y}$$

$$m_t = \frac{M_t - M}{Y}$$

$$t_t = \frac{T_t - T}{Y}$$

$$b_t = \frac{\left(\frac{B_t}{P_{t-1}}\right) - \left(\frac{B}{P}\right)}{Y}$$

where nm_t, m_t and t_t are expressed as deviations from their respective steady states and normalized by steady state output, whereas budget deficit is given by the real deficit at time t, divided by the last period's prices minus the steady state nominal deficit and normalized by steady state of output.

Fiscal policy rules have been studied extensively, for instance, by Bohn (1998) and Galì and Perotti (2003). Here, we assume an extension that allows us to consider the two different fiscal policy components:

$$t_t = \phi_b b_t + \phi_{nm} nm_t + \phi_m m_t \qquad \text{(Eq. A36)}$$

where ϕ_{nm} and ϕ_m are parameters indicating the response of taxes to civilian and military expenditures, respectively. ϕ_b is the parameter capturing the response of taxes to budget deficit in the case of increases in civilian and military expenditures.

If we insert the fiscal policy rule (Eq. A36) into the linearized budget constraint (Eq. A35), we obtain:

$$b_{t+1} = \frac{1}{\beta}\left(1 - \phi_b\right) b_t + \frac{1}{\beta}\left(1 - \phi_{nm}\right) nm_t + \frac{1}{\beta}\left(1 - \phi_m\right) m_t \qquad \text{(Eq. A37)}$$

A necessary and sufficient condition for non-explosive deficit dynamics is given by:

$$\frac{1}{\beta}\left(1 - \phi_b\right) b_t < 1 \Rightarrow \phi_b > 1 - \beta \qquad \text{(Eq. A38)}$$

This assumption is crucial in order to choose the value of ϕ_b in the model calibration.

Civilian and military expenditures (in deviations from their respective steady states, and normalized by output steady state) evolve exogenously, according to two distinct first order autoregressive processes. Indeed, we assume that the resources destined for civilian and military sectors are AR(1) processes in line with the dynamic responses of our VAR based estimates:

$$\begin{aligned} nm_t &= \rho_{nm} nm_{t-1} + +\epsilon_t^{nm} \\ \text{where} &: 0 < \rho_{nm} < 1 \\ \epsilon_t^{nm} &\sim N\left(0, \sigma_\epsilon^2\right) \end{aligned} \tag{Eq. A39}$$

and:

$$\begin{aligned} m_t &= \rho_m m_{t-1} + +\epsilon_t^m \\ \text{where} &: 0 < \rho_m < 1 \\ \epsilon_t^m &\sim N\left(0, \sigma_\epsilon^2\right) \end{aligned} \tag{Eq. A40}$$

where ρ_{nm} and ρ_m are the persistence parameters, whereas ϵ_t^{nm}, ϵ_t^m are i.i.d. shock of civilian and military expenditures.

2.8. *Aggregation and market equilibrium*

The sum of the ricardian and non-ricardian consumption shares gives aggregate consumption:

$$C_t \equiv \lambda C_t^{nr} + (1 - \lambda) C_t^r \tag{Eq. A41}$$

Similarly, adding labor supplied by ricardian and non-ricardian households gives total hours:

$$N_t \equiv \lambda N_t^{nr} + (1 - \lambda) N_t^r \tag{Eq. A42}$$

By our assumption, all capital stock is held by ricardian households:

$$K_t \equiv (1-\lambda) K_t^r \tag{Eq. A43}$$

and aggregate investment is given by:

$$I_t \equiv (1-\lambda) I_t^r \tag{Eq. A44}$$

A dynamic stochastic general equilibrium is a set of values for prices and quantities such that the representative household's and firm's optimality conditions, and the market clearing conditions are satisfied. In this case, the clearing of factor markets implies:

$$N_t = \int_0^1 N_t(j)\, dj \tag{Eq. A45}$$

$$K_t = \int_0^1 K_t(j)\, dj \tag{Eq. A46}$$

$$Y_t(j) = X_t(j) \text{ for all } j \tag{Eq. A47}$$

Final good market is in equilibrium if production equals demand by total household consumption, aggregate private investment and total government spending:

$$Y_t = C_t + I_t + NM_t + M_t \tag{Eq. A48}$$

3. Appendix C: Log-linearized equilibrium conditions

3.1. *Steady state analysis*

In this short section we show that the steady state ratio of aggregate consumption to total output does not depend upon the fraction of non-Ricardian consumers. In doing so, we just notice that the market clearing condition for final goods implies that:

$$Y_t = C_t + I_t + NM_t + M_t \Rightarrow C_t = Y_t - I_t - NM_t - M_t \tag{Eq. A49}$$

in steady state:

$$C = Y - I - NM - M \qquad \text{(Eq. A50)}$$

dividing by Y and knowing that $\frac{I}{K} = \delta$, we can write:

$$\gamma_c = 1 - \frac{\delta\alpha}{\alpha\frac{Y}{K}} - \gamma_{nm} - \gamma_m \qquad \text{(Eq. A51)}$$

where $\gamma_c = \frac{C}{Y}$, $\gamma_{nm} = \frac{NM}{Y}$ and $\gamma_m = \frac{M}{Y}$.

When we consider the marginal product of capital in steady state:

$$\alpha\frac{Y}{K}\lambda_t(j) = R^k \qquad \text{(Eq. A52)}$$

and the FOC of the intermediate firm's problem in steady state:

$$MC = \frac{1}{\mu_p} = \lambda_t(j) \qquad \text{(Eq. A53)}$$

we obtain:

$$R^k = \frac{\alpha Y}{\mu_p K} \qquad \text{(Eq. A54)}$$

Knowing that:

$$R^k = \frac{1}{\beta} - 1 + \delta \qquad \text{(Eq. A55)}$$

we can equate:

$$R^k = \frac{1}{\beta} - 1 + \delta = \frac{\alpha Y}{\mu_p K} = R^k_t \qquad \text{(Eq. A56)}$$

solving for:

$$\frac{1}{\beta} - 1 + \delta = \frac{\alpha Y}{\mu_p K} \Rightarrow \alpha\frac{Y}{K} = \mu_p\left(\frac{1}{\beta} - 1 + \delta\right) \qquad \text{(Eq. A57)}$$

Finally, we obtain:

$$\begin{aligned}
\gamma_c &= 1 - \frac{\delta\alpha}{\alpha\frac{Y}{K}} - \gamma_{nm} - \gamma_m \\
&= (1 - \gamma_{nm} - \gamma_m) - \frac{\delta\alpha}{\alpha\frac{Y}{K}} \\
&= (1 - \gamma_{nm} - \gamma_m) - \frac{\delta\alpha}{\mu_p\left(\frac{1}{\beta} - 1 + \delta\right)} \qquad \text{(Eq. A58)}
\end{aligned}$$

This result confirms that the steady state ratio between consumption and output is independent from share of non-Ricardian consumers.

3.2. *Log-linearized equations*

In the present section we derive the log-linear versions of the key optimality and market-clearing conditions used in our analysis of the model's equilibrium dynamics. Some of these conditions hold exactly, whereas others represent first-order approximations around a zero-inflation steady state. Henceforth, and unless otherwise noted, lower-case letters denote log-deviations with respect to the corresponding steady state values:

$$x_t \equiv \log \frac{X_t}{X}$$

Tobin's q equation is obtained log-linearizing expression (Eq. A13):

$$q_t = \beta E_t \left\{q_{t+1}\right\} + \left[1 - \beta\left(1-\delta\right)\right] E_t \left\{r^k_{t+1}\right\} - \left(r_t - E_t\left\{\pi_{t+1}\right\}\right) \qquad \text{(Eq. A59)}$$

The investment equation is obtained log-linearizing (Eq. A14):

$$i_t - k_t = \eta q_t \qquad \text{(Eq. A60)}$$

The capital accumulation equation is obtained log-linearizing (Eq. A4):

$$k_{t+1} = \delta i_t + \left(1-\delta\right) k_t \qquad \text{(Eq. A61)}$$

The log-linearized Euler equation for Ricardian households is given log-linearizing (Eq. A9):

$$c^r_t = E_t\left\{c^r_{t+1}\right\} - \left(r_t - E_t\left\{\pi_{t+1}\right\}\right) \qquad \text{(Eq. A62)}$$

The log-linearized equation of consumption for non-Ricardian households is obtained from equation (Eq. A17):

$$c^{nr}_t = \left(\frac{WN^{nr}}{C^{nr}}\right)\left(w_t + n^{nr}_t\right) - \left(\frac{Y}{C^r}\right) t^{nr}_t \qquad \text{(Eq. A63)}$$

$$\text{since} \quad : \quad t^{nr}_t = \frac{T^{nr}_t - T^{nr}}{Y}$$

The log-linearized expression for aggregate consumption is obtained, assuming $C^r = C^o = C$, from equation (Eq. A41):

$$c_t = \lambda c_t^{nr} + (1-\lambda)\, c_t^r \qquad \text{(Eq. A64)}$$

Equivalently, the log-linearized expression for hours worked is obtained from (Eq. A42):

$$n_t = \lambda n_t^{nr} + (1-\lambda)\, n_t^r \qquad \text{(Eq. A65)}$$

Since we have assumed a non-competitive labor market structure, after some computation we can obtain the intertemporal equilibrium condition for aggregate consumption:

$$\begin{aligned} c_t &= E_t\{c_{t+1}\} - \frac{1}{\tilde{\sigma}}\left(r_t - E_t\{\pi_{t+1}\}\right) \qquad \text{(Eq. A66)} \\ &\quad -\Theta_n E_t\{\Delta n_{t+1}\} + \Theta_t E_t\left\{\Delta t_{t+1}^r\right\} \\ \text{where} &: \frac{1}{\tilde{\sigma}} = \gamma_c \Phi \mu^p (1-\lambda) \\ \Phi &= \left(\gamma_c \mu^p - \lambda(1-\alpha)\right)^{-1} \\ \Theta_n &= \lambda \Phi (1-\alpha)(1+\varphi) \\ \Theta_t &= \lambda \Phi \mu^p \end{aligned}$$

Log-linearization of expressions (Eq. A31) and (Eq. A32) gives the inflation equation:

$$\begin{aligned} \pi_t &= \beta\{\pi_{t+1}\} - \lambda_p \hat{\mu}_t^p \qquad \text{(Eq. A67)} \\ \text{where} &: \lambda_p = (1-\beta\theta)(1-\theta)\frac{1}{\theta} \\ \text{and} &: mc_t = \hat{\mu}_t^p \end{aligned}$$

From the firms' maximization profit we also obtain the price mark-up equation:

$$\hat{\mu}_t^p = (y_t - n_t) - w_t = (y_t - k_t) - r_t^k \qquad \text{(Eq. A68)}$$

The log-linearized aggregate production function is obtained from expression (Eq. A25):

$$y_t = (1-\alpha)\, n_t + \alpha k_t \qquad \text{(Eq. A69)}$$

The log-linearized expressions for the monetary policy function, the government budget constraint, the fiscal policy rule, the civilian spending shock and the military spending shock have been shown above - (Eq. A33), (Eq. A35), (Eq. A36), (Eq. A39) and (Eq. A40), respectively.

Finally, log-linearization of the market-clearing condition of the final goods (Eq. A48) around the steady state yields the following expression:

$$\begin{aligned} y_t &= \gamma_c c_t + \gamma_i i_t + n m_t + m_t \qquad \text{(Eq. A70)} \\ \text{where} &: \gamma_c = \frac{C}{Y} \\ \gamma_i &= \frac{I}{Y} \end{aligned}$$

4. Appendix D: Non-competitive labour market

Following Galì et al. (2007), we describe a model of wage determination that generate a log-linear aggregate equilibrium condition corresponding to:

$$w_t = c_t + \varphi n_t \qquad \text{(Eq. A71)}$$

Consider a model with a continuum of unions, each of which represents workers of a certain type. Effective labor input hired by firm j is a CES function of the quantities of the different labor types employed:

$$N_t(j) = \left(\int_0^1 N_t(j,i)^{\frac{\varepsilon_w - 1}{\varepsilon_w}}\, di \right)^{\frac{\varepsilon_w}{\varepsilon_w - 1}}$$

where ε_w is the elasticity of substitution across different types of households. The fraction of non-Ricardian and Ricardian consumers is uniformly distributed across worker types (and hence across unions). Each period, a typical union (say, representing worker of type z) sets the wage for its workers in order to maximize the objective function:

$$\lambda\left[\frac{1}{C_t^{nr}(z)}W_t(z)\,N_t(z)-\frac{N_t^{1+\varphi}(z)}{1+\varphi}\right]+(1-\lambda)\left[\frac{1}{C_t^{r}(z)}W_t(z)\,N_t(z)-\frac{N_t^{1+\varphi}(z)}{1+\varphi}\right]$$

subject to a labor demand schedule:

$$N_t(z)=\left(\frac{W_t(z)}{W_t}\right)^{-\varepsilon_w}N_t$$

As argued by Galì et al. (2007), because consumption will generally differ between the two types of consumers, the union weighs labor income with their respective marginal utility of consumption (i.e., $\frac{1}{C_t^{nr}}$ and $\frac{1}{C_t^{r}}$). Notice that, in writing down the problem, we have assumed that the union takes into account the fact that firms allocate labor demand uniformly across different workers of type z, independently of their household type. It follows that, in the aggregate, we will have $N_t^{nr}=N_t^{r}=N_t$ for all t. The first order condition of this problem can be written as follows:

$$\left[\frac{\lambda}{MRS^{nr}}+\frac{1-\lambda}{MRS^{r}}\right]W=\mu^w \qquad \text{(Eq. A72)}$$

where:

$$\begin{aligned}MRS^{nr} &= C^{nr}N^{\varphi}\\ MRS^{r} &= C^{r}N^{\varphi}\\ \mu^{w} &= \frac{\varepsilon_w}{\varepsilon_w-1}\end{aligned}$$

Log-linearizing expression (Eq. A72) and ignoring constant terms yields the wage schedule:

$$w_t=\chi_{nr}mrs_t^{nr}+\chi_r mrs_t^{r}=\tilde{c}_t+\varphi\left(\chi_{nr}+\chi_r\right)n_t$$

where:

$$\begin{aligned}\chi_{nr} &= \frac{\lambda W}{MRS^{nr}\mu^{w}}\\ \chi_{r} &= \frac{(1-\lambda)\,W}{MRS^{r}\mu^{w}}\\ \tilde{c}_t &= \chi_{nr}c_t^{nr}+\chi_r c_t^{r}\end{aligned}$$

We note that, to the extent that tax policy equates steady state consumption across household types (i.e., $C^{nr} = C^{r}$) we will have:

$$MRS^{nr} = MRS^{r}$$

and, hence:

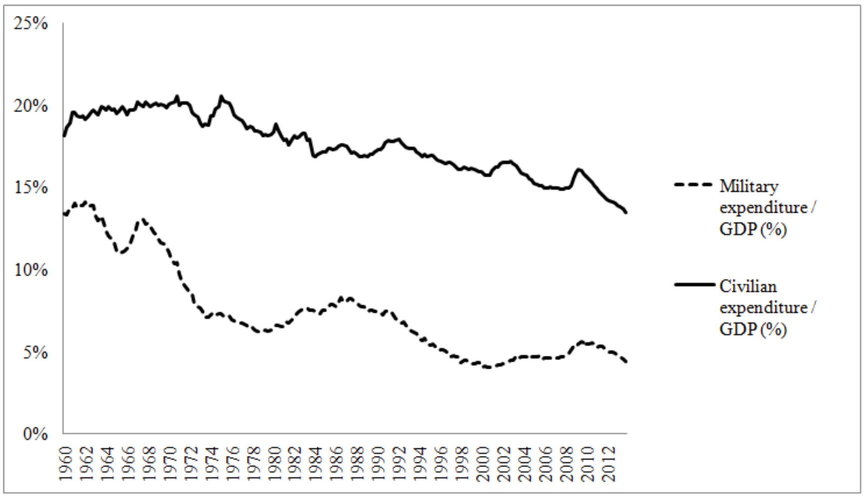
$$\begin{aligned}\chi_{nr} &= \lambda\\ \chi_{r} &= 1-\lambda\end{aligned}$$

We can then rewrite the previous equilibrium condition as:

$$w_t = c_t + \varphi n_t$$

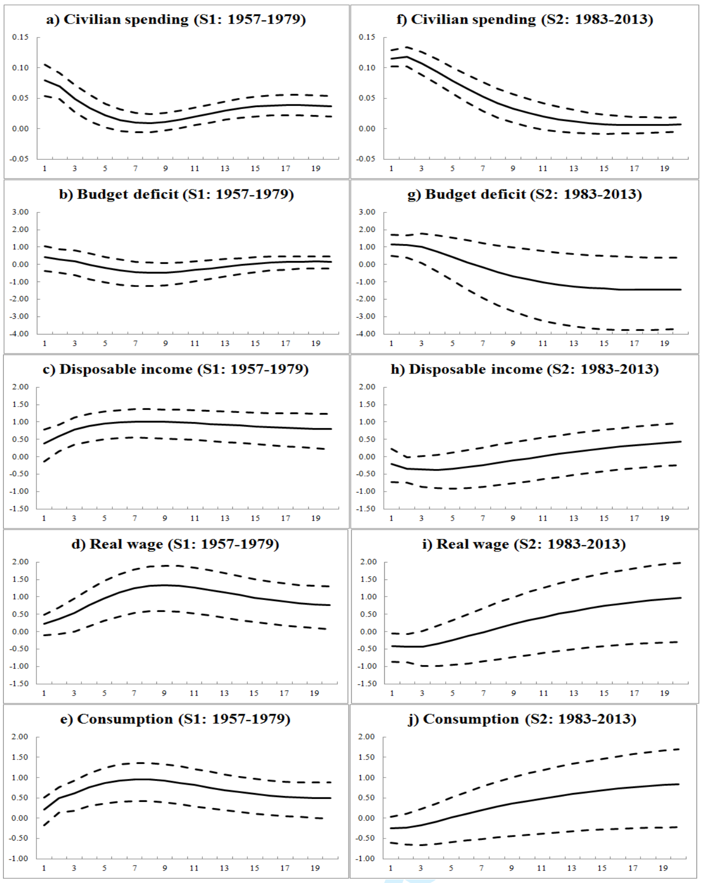
Finally, as noted by Galì et al. (2007), under the present scenario we assume that the wage markup μ^{w} is sufficiently large (and the shocks sufficiently small) so that the conditions $W_t > MRS_t^{j}$ for $j = nr, r$ are satisfied for all t. Both conditions guarantee that both type of households will be willing to meet firms' labor demand at the prevailing wage.

5. Appendix E: Additional figures and tables



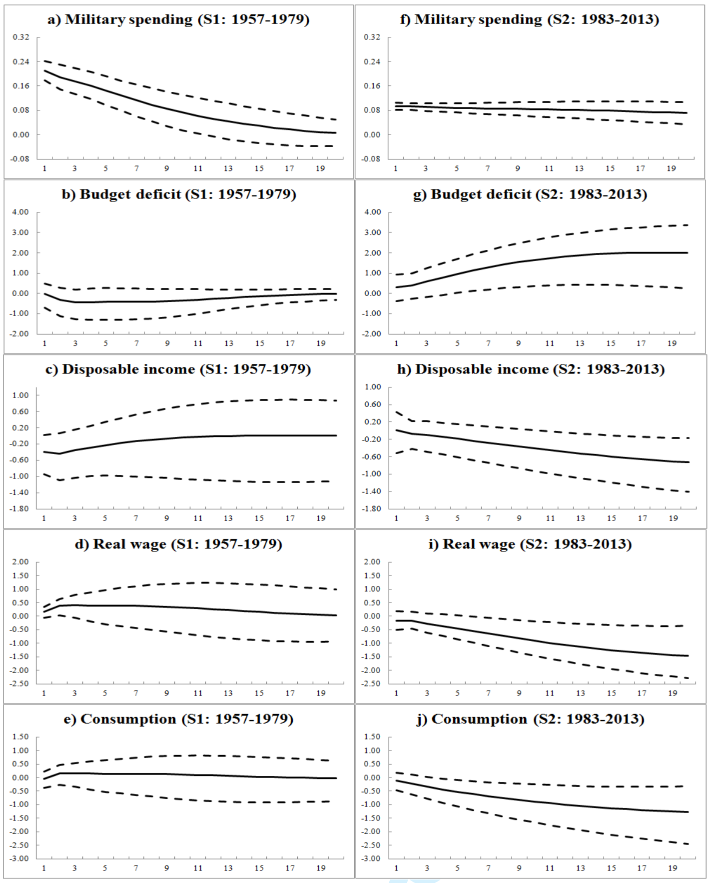
The relative shares of civilian and military expenditures on GDP are obtained from the Bureau of Economic Analysis (National Economic Accounts)

Figure E.1. Civilian and military expenditures as shares of GDP



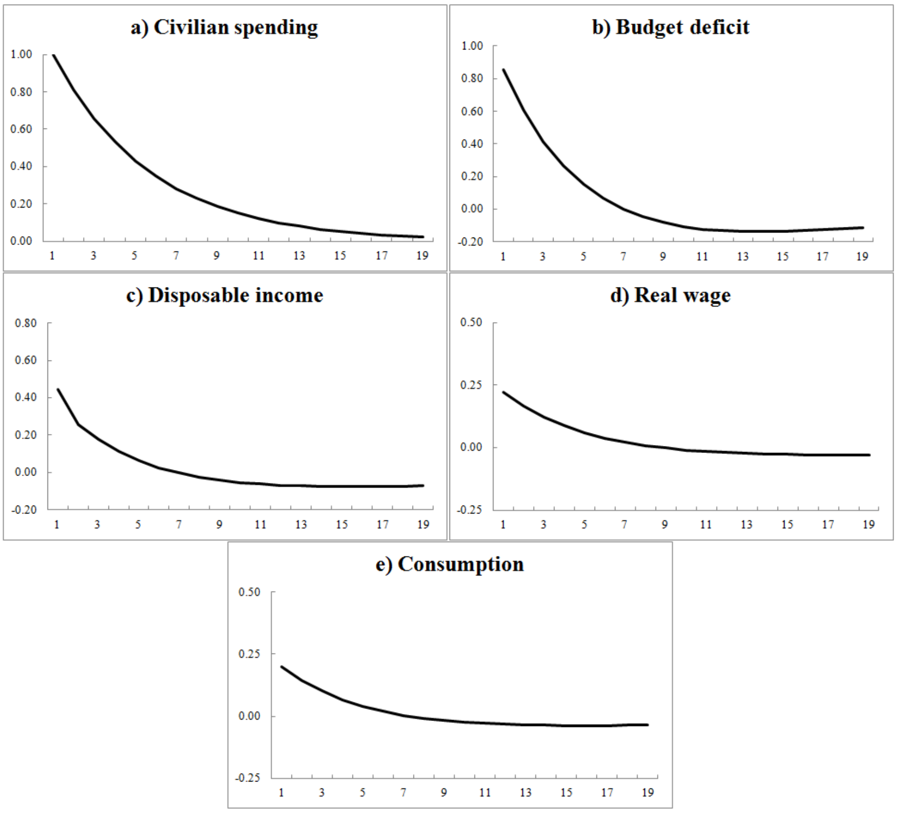
Estimated impulse responses to a civilian spending shock in SVAR. Sample periods: $1960 : Q1 - 1979 : Q2$ (S1) and $1983 : Q1 - 2013 : Q4$ (S2). Vertical axes indicate deviations from unshocked path. Horizontal axes indicate quarters after shock. Confidence intervals at the usual 95% significant level based on 10,000 Monte Carlo replications.

Figure E.2. Subsample estimates: Response of the VAR model to a civilian spending shock



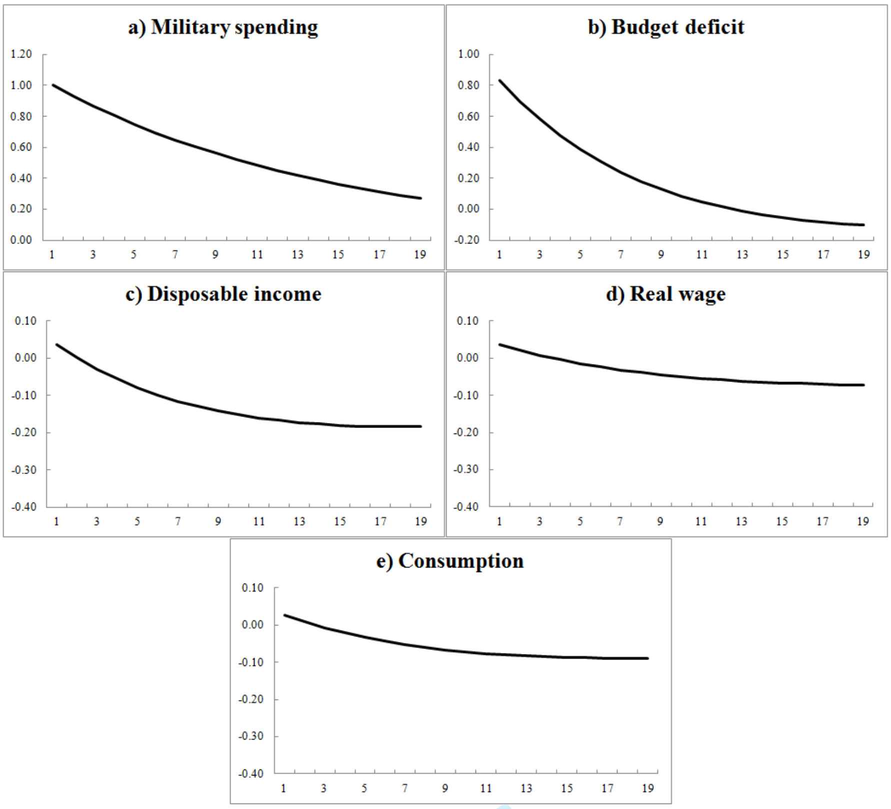
Estimated impulse responses to a military spending shock in SVAR. Sample periods: $1960:Q1-1979:Q2$ (S1) and $1983:Q1-2013:Q4$ (S2). Vertical axes indicate deviations from unshocked path. Horizontal axes indicate quarters after shock. Confidence intervals at the usual 95% significant level based on 10,000 Monte Carlo replications.

Figure E.3. Subsample estimates: Response of the VAR model to a military spending shock



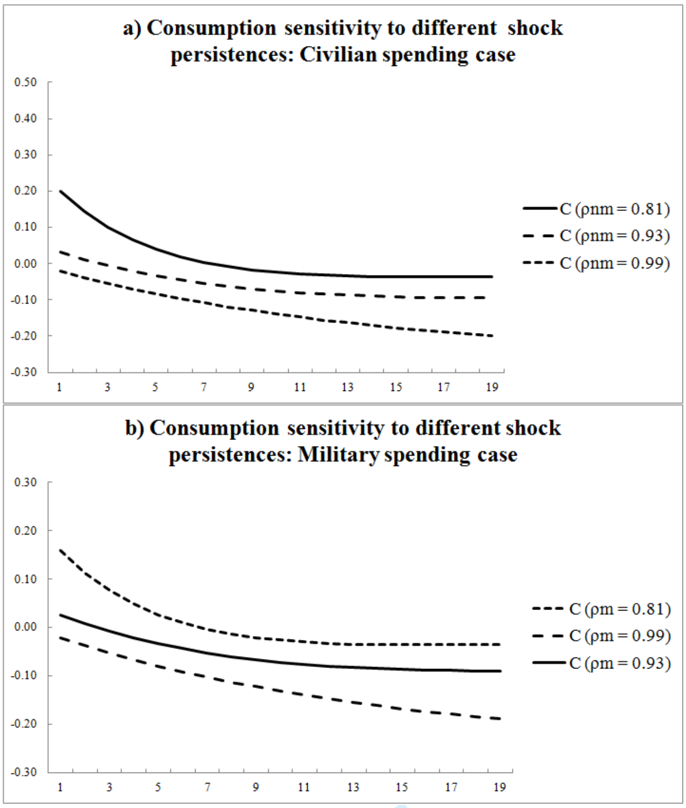
The shock is normalized to 1% of civilian expenditure in steady state. Vertical axes indicate deviations from the steady state. Horizontal axes indicate quarters after shock.

Figure E.4. Dynamic effects of a civilian spending shock



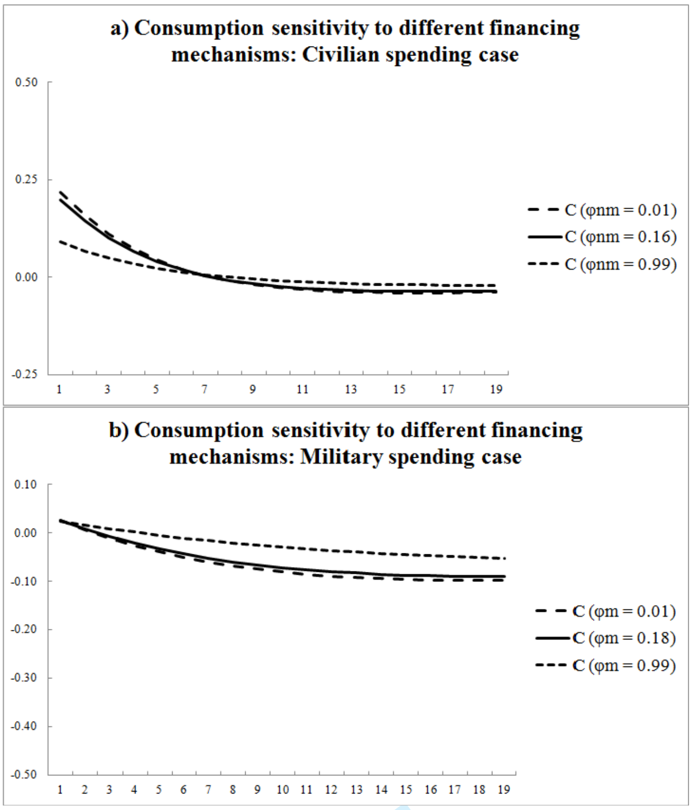
The shock is normalized to 1% of military expenditure in steady state. Vertical axes indicate deviations from the steady state. Horizontal axes indicate quarters after shock.

Figure E.5. Dynamic effects of a military spending shock



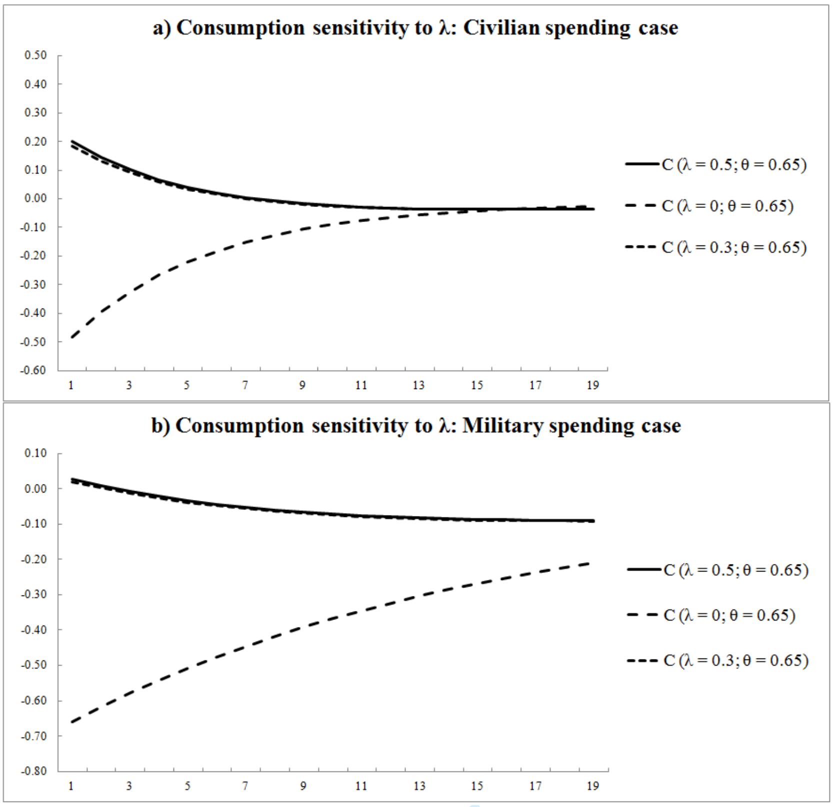
For civilian spending, the solid black line corresponds to $\rho_{nm} = 0.81$, the dashed black line to $\rho_{nm} = 0.93$ and the dotted black line to $\rho_{nm} = 0.99$; for military spending, the solid black line corresponds to $\rho_m = 0.93$, the dashed black line to $\rho_m = 0.81$ and the dotted black line to $\rho_{nm} = 0.99$.

Figure E.6. Consumption sensitivity: Different shock persistences of civilian and military expenditures



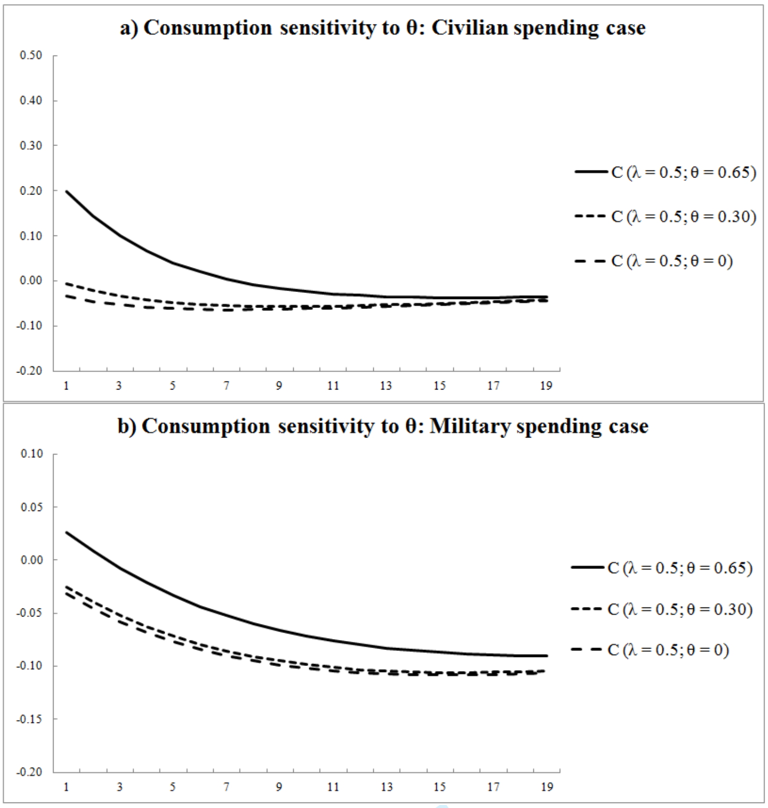
For civilian spending, the solid black line corresponds to $\phi_{nm} = 0.16$, the dashed black line to $\phi_{nm} = 0.01$ and the dotted black line to $\phi_{nm} = 0.99$; for military spending, the solid black line corresponds to $\phi_m = 0.18$, the dashed black line to $\phi_m = 0.01$ and the dotted black line to $\phi_m = 0.99$.

Figure E.7. Consumption sensitivity: Different financing mechanisms of civilian and military expenditures



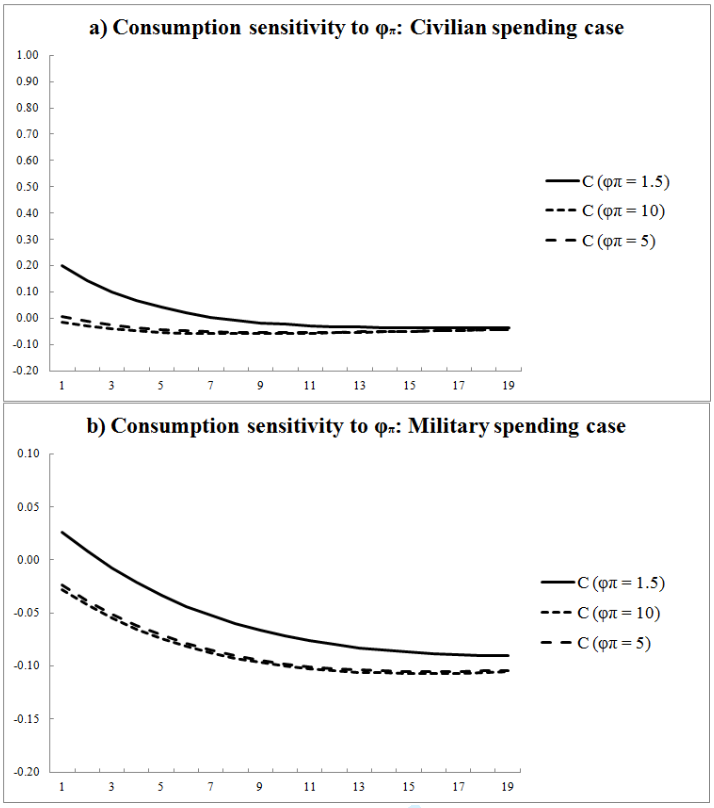
In both civilian and military shocks, the solid black lines correspond to benchmark values of λ and θ, the dashed black lines to $\lambda = 0$ and $\theta = 0.65$ and the dotted black lines to $\lambda = 0.3$ and $\theta = 0.65$.

Figure E.8. Consumption sensitivity for different values of λ



In both civilian and military shocks, the solid black lines correspond to benchmark values of λ and θ, the dotted black lines to $\lambda = 0.5$ and $\theta = 0.30$ and the dashed black lines to $\lambda = 0.5$ $\theta = 0$.

Figure E.9. Consumption sensitivity for different values of θ



In both civilian and military shocks, the solid black lines correspond to benchmark value of ϕ_π, the dotted black lines to $\phi_\pi = 10$ and the dashed black lines to $\phi_\pi = 5$.

Figure E.10. Consumption sensitivity for different values of ϕ_π

Estimated fiscal policy multipliers on output				
Quarters	1	4	8	12
Civilian spending	0.37	1.01	1.49	1.62
	[0.34/0.41]	[0.96/1.06]	[1.43/1.54]	[1.56/1.68]
Military spending	-0.23	-0.35	-0.41	-0.44
	[-0.21/-0.26]	[-0.32/-0.38]	[-0.37/-0.44]	[-0.40/-0.48]

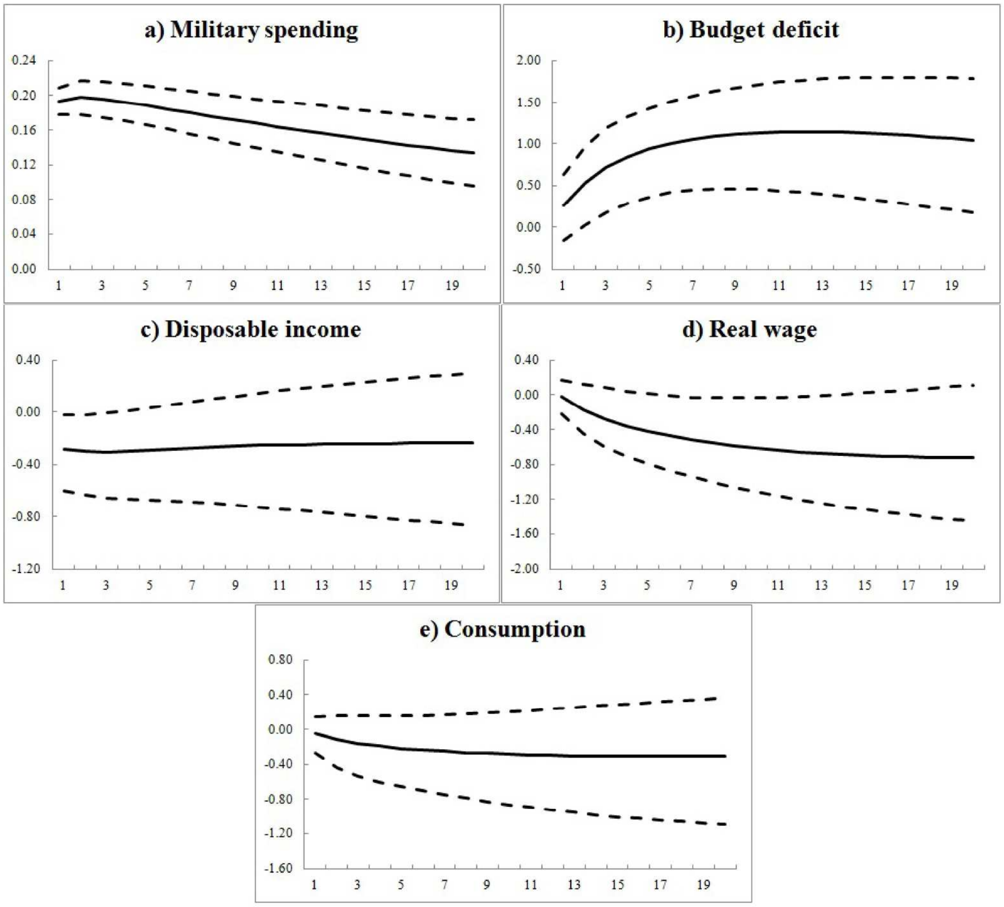
Results from cumulated IRFs. 95% confidence intervals (CI) are listed in brackets.

Table E.I. Estimated fiscal policy effects (civilian and military spending) on output

S1: Estimated fiscal policy multipliers on output				
Quarters	1	4	8	12
Civilian spending	1.25	2.32	2.03	1.26
	[1.17/1.32]	[2.22/2.42]	[1.94/2.11]	[1.19/1.32]
Military spending	0.10	0.05	0.00	-0.08
	[0.06/0.13]	[-0.12/0.21]	[-0.38/0.39]	[-0.69/0.54]
S2: Estimated fiscal policy multipliers on output				
Quarters	1	4	8	12
Civilian spending	-0.25	0.04	0.45	0.69
	[-0.21/-0.28]	[-0.01/0.10]	[0.38/0.52]	[0.61/0.77]
Military spending	-0.15	-0.53	-0.90	-1.12
	[-0.11/-0.19]	[-0.48/-0.57]	[-0.84/-0.95]	[-1.06/-1.19]

Results from cumulated IRFs. 95% confidence intervals (CI) are listed in brackets.

Table E.II. Subsample estimates, fiscal policy effects (civilian and military spending) on output



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